C. LYELL.

ON THE TERTIARY STRATA

OF BELGIUM AND FR. FLANDERS

1852

M. de Koninck
with the author's regards

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OF

BELGIUM AND FRENCH FLANDERS.

BY

SIR C. LYELL, F.R.S., V.P.G.S.

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CONTENTS.

[PLATES XVII. to XX.]

§ 1. THE following observations are the result of a visit made in the summer of last year (1851) to parts of French Flanders and Belgium, undertaken with a view of comparing the tertiary strata of that part of the continent with those of England.

I shall first describe what I saw of the newest deposits, and then proceed to consider the others in a descending series until I arrive at strata which repose immediately on the chalk of Maestricht.

For convenience of reference, and in explanation of the nomenclature adopted, a synoptical table of formations (Table I.) is annexed.

§ 2. *Loess or Lehm* (A. Table I.). *Limon de Hesbaye* of M. Dumont.

The southern half of Belgium is overspread almost everywhere by a continuous deposit of clayey loam, resembling in colour and composition the well-known "loess" of the Rhine. This loam has been called "Hesbayan mud" by M. Dumont, because it abounds in the ancient province of Hesbaye, which includes, among other areas, the country between Liege and Waremme and between Liege and Tongres. It presents generally the same uniformity of aspect and composition, and the same absence of stratification which characterize it on the Rhine between Cologne and Basle. In Belgium, however, land and freshwater shells are much more rare, and the only spot where I met with any was at the village of Neerepen, between Tongres and Hasselt (see Map, Pl. XVII. fig. 4), where they had been previously remarked by M. Bosquet. Here I found abundantly the *Succinea oblonga*, so common in the Rhenish loess, and *Helix hispida*. The tusks of a fossil Elephant were also obtained here by M. Bosquet. The only shells which I heard of as having been detected elsewhere in the Belgian loess consisted of recent species, all of terrestrial or fluviatile genera.

The thickness of the "Hesbayan mud" is variable, usually ranging from 10 to 30 feet. It is seen capping some of the highest hills or table-lands near Brussels; as for example, that above the villages of Jette and Dileghem, west of Laeken (see Map, Pl. XVII. fig. 3), at the height of about 300 feet above the sea. At the base of the loess, or between it and the older rocks, there occur very generally one or more beds of gravel. In some cases, as I shall hereafter have to point out, where it rests on unconsolidated tertiary sands and loams, there is such an intermixture of the newer and older deposits, owing to denudation and redeposition (the fossils washed out of the older beds often remaining entire), that it is most difficult to draw a line of separation.

The homogeneous character of the loess throughout the hydrographical basin of the Rhine always disposed me to refer its origin to some common source, such as a great river which had brought down for ages the same kind of sediment, and spread it over a large area, while that area was slowly subsiding. I also supposed that the same region had been subsequently re-elevated and denuded, so that most

Table I.

Synoptical Table of Tertiary Formations of Belgium and French Flanders.*

	Names adopted in this Memoir.	Nomenclature used by M. Dumont in his Map of Belgium.	British equivalents.	French equivalents.	Periods.
A.....	Loess and Alluvium	Limon Hesbayen	Brick-earth, drift, &c.	Alluvions and Loess.	Post-pliocene and Pleistocene.
B. 1. ..	Antwerp Crag	Système Scaldesien.	Red and coralline Crags of Suffolk.	Crag de Carentan, Normandie.	Pliocene.
B. 2. ..	Sands of Diest.....	S. Diestien.			
C.....	Bolderberg Sands	S. Bolderien....	Wanting.....	Faluns de la Loire	Miocene.
D. 1. ..	Upper Limburg Beds, or Rupelmonde Clay.	S. Rupelien.	Upper freshwater, and upper marine of the Isle of Wight.	Calcaire de la Beauce.	Upper Eocene (Lower Miocene of many authors).
D. 2. ..	Middle Limburg, or Fluvio-marine.	S. Tongrien supérieur.		Sables et Grès de Fontainebleau. Marnes à Ostrea cyathula.	
D. 3. ..	Lower Limburg	S. Tongrien inférieur.		Marnes supérieurs au gyps.	
E. 1. ..	Laeken Beds, or Upper Nummulitic (*Nummulites variolarius*).	S. Laekenien....	Barton Clay	Sables moyens ou Grès de Beauchamp.	Middle (or Nummulitic) Eocene.
E. 2. ..	Brussels Beds, or Middle Nummulitic (*Nummulites lævigatus*).	S. Bruxellien....	Bagshot and Bracklesham Beds.	Calcaire grossier.	
E. 3. ..	Lower Nummulitic Beds (*Nummulites planulatus*).	S. Paniselien?, and S. Ypresien, étage supérieur.		Sables Soissonnais, partie supérieure.	
F. 1. ..	London Clay	S. Ypresien, étage inférieur.	London Clay proper.	Wanting.....	Lower Eocene.
F. 2. ..	Plastic Clay and Sands ..	S. Landenien supérieur.	Lower London Tertiaries.	Lignite Soissonnais.	
G.	Glauconite and Tufeau of Lincent.	S. Landenien inférieur.	Wanting.		Intermediate between Eocene and Cretaceous.
H.	Marls and Glauconite of Heers.	S. Héersien	Wanting.		
I.	Maestricht Chalk.....	Calcaire de Maestricht.	Wanting.		Cretaceous.

* In Appendix, Nos. I. and II., at the end of this paper, will be found two Tables by M. Dumont, the first published in 1851, and the second previously unpublished, in which that distinguished geologist explains his views respecting the classification of the Belgian tertiary strata, and their synchronism with those of England and France.

of the valleys and inequalities, previously existing before they were filled up with loess, were partially or entirely re-excavated, and some new ones formed*.

Having since the publication of these views had an opportunity of examining the loess of the basin of the Mississippi,—a formation singularly identical in mineral characters and in the genera of its included shells,—my conclusions respecting the nature of the European loess and its mode of origin have been confirmed†.

The phænomena can be best explained, both in Europe and North America, by supposing a gradual subsidence of dry land to the extent of several hundred feet during the deposition of the fluviatile mud, and an equally gradual upheaval of the same tract during the period when extensive denudation was effected. In the same manner as the southern and seaward termination of the loess is somewhat abrupt in Louisiana, where it bounds the delta of the Mississippi, so the corresponding mass of upraised freshwater mud in Belgium ceases somewhat suddenly along a well-marked line, which has been traced out by MM. d'Omalius d'Halloy, Dumont, and others, running east and west nearly along the 51st parallel of latitude, by Cologne, Juliers, Louvain, Audenaerde, and Courtray in Belgium, to Cassel, near Dunkirk, in France. Whether this line indicates the original extent of a fluviatile formation, or whether it was produced by the denudation of a deposit once stretching farther north, I am unable to decide. Its absence beyond the line alluded to is of great importance to a geologist who is examining the tertiary strata of the low countries bordering the sea, for it allows them to appear at the surface, except where they are concealed by fine sand, much resembling the dunes on the coast. Everywhere to the south of lat. 51° the loess greatly impedes the geological observer, not only by its continuity and thickness, but also by producing a soil so favourable to agriculture, that sand-pits, excavations for clay, or quarries of building-stone, paving-stone, limestone, and other materials, if opened, are almost always filled up immediately, in order that no space may be lost to the farmer. The geologist, therefore, in a country where natural sections are rare, is often reduced to such artificial ones as happen to be exhibited during the workings of a single year.

In regard to the relative ages of the loess and the northern drift, with its erratics, the only positive information which I obtained during this tour was on crossing the Meuse from Maestricht to the right bank of that river, opposite the city. Here, in company with M. Van Rymsdyck, I observed that the sands of the Limburg tertiary series were covered by a bed of quartzose gravel with erratics, and this again by loess 30 feet thick. The locality alluded to is the table-land of Rassburg, near Geulem, which is about 300 feet above the Meuse, and about 450 feet above the level of the sea. The erratics are some of them very angular, and more than 2 feet in diameter, consisting of quartzose slate, similar to that of the Ardennes, from which they are believed to have been transported.

* See Proceed. Geol. Soc. vol. ii. p. 83; and Edinb. New Phil. Journ. July 1833.

† Second Visit to the United States, vol. ii. p. 294; and *ibid.* chap. xxxiv.

Such an instance of the superposition of loess to a certain class of erratics, will not justify the conclusion that the origin of the loess generally was of later date than the northern drift. I should rather infer from the fact here mentioned, that the transportation by ice of large blocks was still going on when a part of the Belgian loess was deposited;—in other words, the glacial epoch coincided, in part at least, with the epoch of the formation of the loess. I conceive that the more intense cold had passed away, or receded northwards, before the principal mass of the loess was thrown down.

§ 3. *Antwerp Crag* (B. 1. Table I. p. 279). *Système Scaldesien*, Dumont, 1851. *Système Campinien*, Dumont, 1839.

The excellent and well-known work of M. Nyst, published in 1843, on the shells and corals of the tertiary formation of Belgium, has made every geologist familiar with the fact, that a large number of species of fossils are common to the Suffolk Crag and to strata in the neighbourhood of Antwerp. M. Nyst has taken frequent occasion to acknowledge that a considerable proportion of these Antwerp fossils were communicated to him by M. Norbert de Wael, and I was fortunate enough to obtain the friendly cooperation of that excellent observer and indefatigable collector during my visit to Antwerp. He placed most liberally at my disposal, and for my use when writing this memoir, not only a part of his collection, which Mr. Searles Wood has compared with fossils from the English Crag, but also his MS. lists of organic remains, and his notes on the geology of the localities most fertile in fossils, several of which we visited together.

There are no natural sections to be seen in the flat country around Antwerp, but excavations to the depth of a few feet in the town and its suburbs are continually exposing to view beds of sand and shells. One of these I found in progress on my arrival on the eastern side of the city, in the Zoological Gardens. Here they were digging ponds 20 feet deep, from which yellow sand had been thrown out, containing *Fusus contrarius*, *Voluta Lamberti*, *Pecten maximus*, *Pecten opercularis*, *Ostrea edulis*, *Cyprina tumida*, *Astarte borealis*, and many others, which I at once recognized as among the most common shells of the Suffolk Crag. I also observed that they had met with many large vertebræ of Whales in a perfect and unrolled state. I obtained one of these, measuring 6½ inches in its longitudinal, and as much in its transverse diameter, and Prof. Owen has pronounced it to be the lumbar vertebra of a *Balænoptera*. These cetacean relics, which are very common in the district, were associated with large Sharks' teeth, of the genus *Carcharodon*.

At Steuvenberg (a name which implies a hill of sand), east of the fortifications and north of the Zoological Gardens, I found excavations for sand, in which many of the same shells were seen, with others which will be alluded to in the sequel.

On the northern glacis of the fortifications I saw that a very different sand had been recently thrown up from a depth of 20 feet, consisting of a dark green and almost black glauconite. This is called "crag noir," or glauconiferous crag. It contains many of the

same species of shells which I had seen in the yellow crag, but mixed with some others peculiar to it. The *Pectunculus variabilis*, Sow., is by far the most abundant shell.

On the glacis, at a higher level, greyish sand with green grains appears, which M. de Wael calls "crag gris or moyen," and which he regards as of intermediate age between the "yellow" and "black" crags already alluded to.

About three miles south of Antwerp, between the villages of Berchem and Vieux Dieu, I came accidentally upon a new excavation in a garden which exhibited the crag under a different aspect. At the top were mottled, red, and whitish sands, 12 feet thick, the lowest layers containing many small quartz-pebbles, under which was an argillaceous sand with numerous ball-like concretions of clay-stone in which were casts of large Bivalves, chiefly of *Pectunculus* (*P. variabilis*?), and others apparently referable to a large *Mactra* and to a *Venus*, each of which had served as the nucleus of a nodule. The vertebræ of Fish and teeth of Sharks were numerous. Among the latter one large tooth belongs to *Oxyrhina trigonodon*, Agassiz, which I also obtained from the clay of Rupelmonde. A second species comes nearest to *Carcharodon Escheri*, Agassiz, and may perhaps be identical, although less oblique than the specimen figured by Agassiz, who procured his fossil from the Molasse of Switzerland. I found mixed with these many unrolled bones of Whales of a different species from that which I had seen in the yellow crag at Antwerp. Prof. Owen was able from my specimens to refer these bones to the caudal and cervical vertebræ of some species of Cuvier's extinct genus *Ziphius*. The caudal vertebra is $3\frac{1}{2}$ inches in its larger diameter. I was told of many other places where cetacean relics occur near Antwerp; and M. Van Beneden, in his memoir on the subject, states that it is scarcely possible to penetrate a few feet beneath the soil at the villages of Wommelghem and Deurne without encountering cetacean remains which have formed parts of entire skeletons buried on the spot. Some of these fossils, dug up at Antwerp within the walls of the city, were figured by Cuvier, and referred to his genus *Ziphius**. At Niel, near Antwerp, M. Van Beneden met with an ear-bone, which he ascribes to the genus Rorqual or *Balænoptera*†.

We may therefore regard such cetaceans as truly characteristic of the Antwerp Crag; a fact strongly confirmatory of the opinion entertained by Mr. Searles Wood and Mr. Charlesworth, and advocated by myself in 1851‡, that the cetacean relics met with in the Crag of Suffolk, much worn and rolled, have not been derived from the London clay, as some had contended, but were more probably washed out of denuded beds of crag; it being clear that strata in Belgium of the same age as the Suffolk Crag were accumulated in a sea inhabited by numerous Whales belonging to several genera.

The Crag of the neighbourhood of Antwerp, like that of Suffolk, is very variable in composition, and often entirely devoid of fossils.

* Cuv. Oss. Foss. pl. 27. figs. 7 & 8.

† Bullet. Acad. Roy. de Belgique, 1846, vol. xiii. pt. 1. p. 257.

‡ Manual of Geology, 3rd edit. p. 166.

In some districts near the sea it is concealed beneath a superficial covering of stiff tenacious clay of fluviatile origin, provincially called "Polders," full of recent land and freshwater shells, and resembling the dark-coloured clay now deposited by the Scheldt during its annual inundations.

In the absence, therefore, of natural sections, it is not always possible to obtain good proofs of the relative position of particular masses of sands and clay occurring here and there at the surface, although the same have appeared to MM. Nyst and De Wael to contain internal or palæontological evidence of being of different ages. This conclusion has been deduced principally from the greater or less agreement of the shells with living species, especially with those now existing in the neighbouring sea;—a subject to which I shall refer more fully in the sequel.

1. *Yellow Crag. Upper Antwerp Crag.*

At Calloo, one of the spots most fertile in fossil shells, situated two leagues N.W. of Antwerp (see Map, Pl. XVII. fig. 1) on the left bank of the Scheldt, M. de Wael observed the following section of strata referred by him to the upper or yellow crag:—

	Thickness. feet.	inches.
1. Mud or "polder"	1	6
2. Clay and loam	3	6
3. Yellow sand	1	0
4. Yellow shelly sand	5	0
	11	0

The following is a list of shells from this spot in the collection of M. de Wael, to which, with the assistance of Messrs. Searles Wood and Morris, I have added two columns showing the proportion of Antwerp species common to the Red and Coralline Crag of Suffolk, and another column to indicate which species are still living. In identifying shells, enumerated by M. de Wael in his MS. lists, of which I do not possess specimens from Calloo, we have availed ourselves of M. Nyst's figures and descriptions; but, if any doubt existed as to the species meant, it has been omitted altogether.

The column specifying the rarity or abundance of the shells is furnished by M. de Wael, and may be useful in determining the depth of the sea in which the strata were formed. Where there is a blank in that column, the species are neither common nor rare, although some of them may be very rare in collections owing to their fragility.

Table II.

Table of Shells from the Upper or Yellow Crag, collected by M. Norbert de Wael at Calloo, *near Antwerp.*

		Cor.	Red.	Recent.
1. Solen ensis, *Linn.* ? *Ensis complanatus*, Sow.	.....	*	*	*?
2. Solecurtus candidus?, *Ren.*	very rare.	*	.....	*?
3. Glycimeris angusta, *Nyst*	rare.	*	*	
4. Mya arenaria, *Linn.*	very rare.	.....	*	*
5. Corbulomya complanata, *Sow.*	rare.	.....	*	
6. Corbula gibba, *Oliv.* *C. planulata*, Nyst.	common.	*	*	*
7. Lutraria elliptica, *Lamk.*	very rare.	*	*	*
8. Mactra solida, *Linn.*	rare.	.....	*	*
9. —— arcuata, *Sow.*	rare.	*	*	
10. —— inequilateralis, *Nyst*	very common.	.....	*	
11. Erycina depressa, *Nyst*	.....	*	*	
12. Ligula alba, *W. Wood*	.....	*	*	*
13. Petricola laminosa, *Sow.*	.....	*	*	
14. Psammobia Dumontii, *Nyst* *P. vespertina*?, Turton.	.....	*	.....	*
15. Tellina Benedenii, *Nyst*	common.	.....	*	
16. —— obliqua, *Sow.*	rare.	*	*	
17. —— crassa, *Pennant* *T. obtusa*, Sow.	rare.	*	*	*
18. —— calcarea, *Gmel.* *T. ovata*, Nyst.	common.	.....	*	*
19. Tellina lupinoides, *Nyst* *T. articulata*, Nyst. *Lucinopsis Lajonkairii*, Payr.	.....	*	*	*
20. Donax striatella, *Brocc.* *Tellina donacina*, Linn.	.....	*	*	*
21. Lucina astarte, *Nyst*	.....	*	*	
22. —— radula, *Lamk.* *L. antiquata*, Sow.	rare.	*	*	*
23. —— digitaria, *Linn.* *L. curviradiata*, Nyst.	.....	*	*	*
24. Cyprina tumida, *Nyst* *C. rustica*, Sow.	.....	*	**	
25. Astarte borealis, *Linn.* *A. plana*, Sow.	very common.	.....	.....	*
26. —— Basterotii, *Lajonk.*	very rare.	*	*	
27. Venus striatella, *Nyst*	very rare.			
28. Artemis exoleta, *Linn.*	common.	*	*	*
29. Cardium Parkinsoni, *Sow.*	.....	.....	*	
30. —— oblongum, *Nyst*	.....	*		
31. —— edule, *var. Linn.* *C. edulinum*, Sow.	common.	*	*	*
32. Cardita scalaris, *Sow.*	rare.	*	*	
33. Nucula lævigata, *Sow.*	common.	*	*	
34. Pectunculus glycimeris, *Linn.* *P. variabilis*, Sow.	.....	*	*	*

TABLE II. (continued).

		Cor.	Red.	Recent.
35. Pecten maximus, *Linn.* ..... *P. complanatus*, Sow.	common.	*	*	*
36. —— opercularis, *Linn.* ..... *P. Sowerbyi*, Nyst.	very common.	*	*	*
37. —— dubius, *Brocchi* ..... *P. radians*, Nyst.	.....	*	*	
38. —— Pusio, *Pennant* ..... *P. striatus*, Sow.	rare.	*	*	*
39. Anomia ephippium, *Linn.*	common.	*	.....	*
40. Ostrea edulis, *Linn.*	common.	*	*	*
41. Emarginula fissura, *Linn.*	very rare.	*	*	*
42. —— crassa, *Sow.*	very rare.	*	*	*
43. Fissurella græca, *Lamk.*	very rare.	*	*	*
44. Calyptræa sinensis, *Desh.* ..... *C. recta*, Sow.	rare.	*	*	*
45. Trochus cinerarius, *Linn.* ..... *T. octosulcatus*, Nyst.	rare.	.....	*	*
46. Littorina suboperta, *Sow.*	rare.	.....	*	
47. Turritella incrassata, *Sow.* (recent, Mediterranean) ..... *T. triplicata*, Brocc.	very rare.	*	*	*
48. Melania terebellata, *Nyst* ..... *Paludestrina terebellata*, S. Wood.	.....	.....	*	
49. Tornatella (Actæon) Noæ, *Nyst.* ...	very rare.	.....	*	
50. Natica crassa, *Nyst*	common.	*		
51. —— Sowerbyi, *Nyst*	rare.	.....	*	
52. Bulla cylindracea, *Pennant* ..... *B. convoluta*, Nyst.	rare.	*	*	*
53. Fusus contrarius, *Gmel.*	.....	.....	*	*
54. —— corneus, *Sow.*	.....	*	*	*
55. Pleurotoma turricula, *Brocch.*	.....	.....	*	
56. —— mitrula, *Sow.*	.....	*	*	*?
57. Purpura tetragona, *Sow.* ..... *Murex alveolatus*, Sow.	very rare.	.....	*	
58. Purpura lapillus, *Linn.* ..... *Murex incrassatus*, Nyst.	rare.	.....	*	*
59. Rostellaria pes pelicani, *Linn.*	rare.	*	*	*
60. Buccinum (Nassa) reticosum, *Sow.* *B. elongatum*, Sow. *B. rugosum*, Sow. *B. reticosum*, Sow.	common.	.....	*	
61. —— labiosum, *Sow.*	rare.	*	*	
62. —— propinquum, *Sow.*	rare.	.....	*	
63. —— undatum, *Linn.* ..... *B. tenerum*, Sow.	rare.	*	*	*
64. Terebra inversa, *Nyst*	rare.	*	*	
65. Voluta Lamberti, *Sow.*	rare.	*	*	
66. Cypræa europæa, *Mont.* ..... *C. coccinelloides*, Sow. *C. coccinella*, Nyst.	rare.	*	*	*
		46	59	37

Three shells of the above list—*Astarte Basterotii*, *Turritella incrassata*, and *Purpura tetragona*—are so rare at Calloo, and so much worn when they occur, that they are believed by M. de Wael to have been derived from an older bed of the Middle or Grey Crag. A single rolled valve of *Astarte corbuloides* is supposed, in like manner, to have been washed out of an older bed. But the admission or omission of these fossils will not be found to affect the following conclusions, which may be drawn from the whole list:—

1st. The result which is most striking, is that out of 66 shells no less than 64 are common to the Suffolk Crag; occurring either in the red or coralline crags. There can, therefore, be no doubt of the contemporaneity of the Upper Crag of Antwerp with the English or Suffolk Crag.

2ndly. Fifty-nine species out of 66 are common to the red, and 45 to the coralline crag, so that the resemblance to the red or upper crag is greatest.

3rdly. Thirty-seven out of 66, or more than half the shells (55 per cent.), have been identified with living species; and the analogy of these with the fauna of the Northern Seas is very great, as in the case of the Crag of Suffolk.

The upper or yellow sand is usually unconsolidated, and for the most part without shells; often micaceous, and occasionally with a slight mixture of argillaceous or calcareous matter. At Steuvenberg, a locality before alluded to, which I visited, in the eastern suburbs of Antwerp, some beds were formerly worked which were so calcareous as to be used for roads, and even burnt for lime; the carbonate of lime appearing to be derived from the decomposition of shells. From this spot M. de Wael has in the course of many years obtained the following shells, which, like those of Calloo, have been compared with British Crag species by Mr. Wood.

Table III.*

Fossil Shells from the Upper or Yellow Crag at Steuvenberg, *in the Eastern suburbs of Antwerp, collected by M. Norbert de Wael.*

		Cor.	Red.	Recent.
1. Solen ensis, *Linn.*	.....	*	*	*
2. Solecurtus candidus, *Ren.*	very rare.	*	.....	*
3. Glycimeris angusta, *Nyst*	rare.	*	*	
4. Corbula gibba, *Oliv.*	.....	*	*	*
5. Corbulomya complanata, *Sow.*	very common.	.....	*	
6. Mactra arcuata, *Sow.*	very rare.	*	*	
7. —— striata, *Nyst*	.....	*?	*?	*
M. dubia, Sow.				
8. Erycina ambigua, *Nyst*	rare.	*	*	
Kellia ambigua, S. Wood.				

* The synonyms given in Table II. are not repeated here.

TABLE III. (continued).

		Cor.	Red.	Recent.
9. Erycina faba, *Nyst* ..... *Montacuta bidentata*, Montag.	.....	*	*	*
10. Petricola laminosa, *Sow.*	rare.	*	*	*
11. Psammobia Dumontii, *Nyst*..... *P. Feroensis*, Lamk.	rare.	*	.....	*
12. Tellina Benedenii, *Nyst*	common.	.....	*	
13. —— calcarea, *Gmel*.....	rare.	.....	*	*
14. —— solidula?, *Pennant*	rare.	.....	.....	*?
15. Donax striatella, *Brocc.*	.....	*	.....	*
16. Lucina astartea, *Nyst*	.....	*	*	
17. —— radula, *Lamk.*	rare.	*	*	*
18. Diplodonta dilatata, *Phil*.....	rare.	*	*	*
19. Astarte borealis, *Linn.*	.....	.....	.....	*
20. —— Basterotii, *Lajonk.*	rare.	*	*	
21. Venus striatella, *Nyst*				
22. Artemis exoleta, *Linn.*	.....	*	*	*
23. Cardium edule var., *Sow.*	common.	*	*	*
24. Cardita scalaris, *Sow.*	rare.	*		
25. Nucula depressa, *Nyst*.....	rare.	*		
26. —— lævigata, *Sow.*	.....	*	*	
27. Pectunculus glycimeris, *Linn.*..... *P. variabilis*, Sow.	rare.	*	*	*
28. Mytilus antiquorum, *Sow.*	rare.	.....	*	*
29. Pecten opercularis, *Linn*.....	rare.	*	*	*
30. Anomia ephippium, *Linn.*	.....	*	.....	*
31. Ostrea edulis, *Linn.*.....	rare.	*	*	*
32. Lingula Dumortieri, *Nyst*	common.	*		
33. Emarginula crassa, *Sow.*	very rare.	*	*	*
34. Calyptræa sinensis, *Linn*.....	rare.	*	*	*
35. Trochus papillosus, *Da Costa* ..... *T. similis*, Sow.	rare.	.....	*	*
36. —— trigonostomus, *Basterot* ..... *Adeorbis subcarinatus*, Wood.....	.....	*	*	*
37. Natica crassa, *Nyst*	.....	*		
38. Scalaria frondicula, *Wood*.....	rare.	*	*	
39. —— subulata, *Sow.*	rare.	*		
40. Turritella incrassata, *Sow*.....	rare.	*	*	*
41. Eulima subulata, *Risso*.....	.....	*	.....	*
42. Tornatella conoidea, *Nyst*	common.	*	.....	*
43. Bulla cylindracea, *Pennant*	common.	*	*	*
44. Auricula pyramidalis, *Sow.* ..... *Conovulus*, Wood.	rare.	.....	*	
45. Rostellaria pes pelicani, *Linn.*.....	rare.	*	*	*
46. Fusus contrarius, *Sow*.....	.....	.....	*	*
47. Buccinum reticosum, *Sow.*	rare.	.....	*	
48. —— labiosum, *Sow*.....	.....	*	*	
49. —— propinquum, *Sow.*	.....	.....	*	
50. Terebra inversa, *Nyst*	rare.	*	*	
51. Voluta Lamberti, *Sow*.....	rare.	*	*	
52. Cypræa Europæa, *Gmel.*	very rare.	*	*	*
		39	37	31

In this list of 52 species it will be seen that no less than 49 species, or all but 3, occur in the Suffolk Crags; 37 in the red, and 39 in the Coralline crag. Thirty-one of the species are recent (60 per cent.), a larger proportion than at Calloo.

2. *Middle or Grey Crag.*—Next in age, in the opinion of M. de Wael, is the grey crag before mentioned, called *Crag gris*, or *Crag moyen*. It has afforded the largest number of fossil shells, as will be seen by the following list.

Table IV.

Fossil Shells from the Middle Crag (Crag moyen *or* Crag gris), *collected by M. Norbert de Wael.*

	Cor.	Red.	Recent.
1. Corbula gibba, *Oliv.*	*	*	*
2. —— (Poromya) granulata, *Nyst*	*	.....	*
3. Mactra striata, *Nyst*	*	*	
4. Syndosmya prismatica, *W. Wood* ..... *Amphidesma prismaticum*, Montag. *Ligula donaciformis*, Nyst.	*	.....	*
5. Tellina obliqua, *Sow.*	*	*	
6. —— lupinoides, *Nyst*	*	*	*
7. —— Benedenii, *Nyst*	.....	*	
8. Lucina radula, *Montag.*	*	*	*
9. —— digitaria, *Linn.*	*	*	*
10. —— astartea, *Nyst*	*	*	
11. Axinus (Cryptodon) sinuosus, *Donov.*	*	.....	*
12. Diplodonta dilatata, *Phil.*	*	*	
13. Cyprina rustica, *Sow.*	*	*	
14. —— islandica, *Linn.*	*	*	*
15. Astarte mutabilis, *Wood* ..... *A. planata*, Nyst (non Sow.).	*	*	
16. —— borealis, *Linn.* ..... *A. plana*, Sow.	.....	.....	*
17. —— Basterotii, *Lajonk.*	*	*	
18. —— Omalii, *Lajonk.*	*	*	
19. —— Burtini, *Lajonk.*	*	*	
20. —— obliquata, *Sow.*	.....	*	
21. —— gracilis, *Goldf.*	*	*	
22. —— corbuloides, *Nyst*			
23. —— sulcata, *Mont.*	.....	*	*
24. Venus spadicea, *Ren.* ..... *V. ovata*, Mont.	*	*	*
25. —— rudis, *Poli*	*	*	*
26. —— imbricata, *Sow.* ..... *Astarte imbricata*, Sow.	*	*	
27. —— minima, *Mont.*	*	*	*
28. —— chione, var., *Linn.* ..... *V. chionoides*, Nyst.	*	.....	*
29. —— turgida, *Sow.* ..... *V. multilamellata*, Nyst. *V. casina*, Linn.	*	*	*?

TABLE IV. (continued).

	Cor.	Red.	Recent.
30. Artemis exoleta, *Linn.*	*	*	*
31. Cardium echinatum, var.?, *Linn.*	.....	*	*
32. —— edule, var., *Linn.*	*	*	*
33. Isocardia cor, *Linn.*	*	*	*
34. Cardita chamæformis, *Sow.*	*	*	
35. —— orbicularis, *Sow.*	*	*	
36. —— scalaris, *Sow.*	*	*	
37. —— squamulosa, *Nyst*	*	*	
38. Nucula depressa, *Nyst*	*		
Leda semistriata, S. Wood.			
39. Limopsis aurita, *Brocchi*	*		
Trigonocœlia sublævigata, Nyst.			
40. Pectunculus glycimeris, *Linn.*	*	*	*
41. Lima subauriculata, *Montag.*	*	.....	*
42. Pecten maximus, *Linn.*	*	*	*
P. grandis, Sow.			
43. —— Westendorpianus, *Nyst*			
44. —— opercularis, *Linn.*	*	*	*
45. —— dubius, *Brocc.*	*	*	
P. radians, Nyst.			
46. —— pusio, *Pennant*	*	*	*
47. —— Gerardii, *Nyst*	*		
48. —— tigerinus, *Müll.*	*	*	*
49. Anomia ephippium, *Linn.*	*	.....	*
50. Ostrea princeps, *S. Wood*	*	*	
51. —— edulis, *Linn.*	*	*	*
52. Terebratula grandis, *Blum.*	*	*	
T. gigantea, Schloth.			
T. variabilis, Sow.			
53. Lingula Dumortieri, *Nyst*	*		
54. Dentalium entale, *Linn.*	*	*	*
D. semiclausum, Nyst.			
D. costatum?, Sow.			
55. Emarginula fissura, *Linn.*	*	*	*
56. —— crassa, *Sow.*	*	*	*
57. Fissurella græca, *Linn.*	*	*	*
58. Calyptræa sinensis, *Linn.*	*	*	*
59. Pileopsis ungarica, *Linn.*	*	*	*
60. Trochus papillosus, *Da Costa*	.....	*	*
T. granosus, Nyst.			
T. similis, Sow.			
61. —— zizyphinus, *Linn.*	*	*	*
T. lævigatus, Sow.			
T. Sedgwickii, Sow.			
62. —— Kickxii, *Nyst*	*	*	
63. —— cinerarius, *Linn.*	.....	*	*
64. Solarium turbinoides, *Nyst*	*		
Margarita maculata, S. Wood.			
65. Littorina suboperta, *Sow.*	.....	*	
66. Scalaria frondicula, *S. Wood*	*	*	

TABLE IV. (continued).

	Cor.	Red.	Recent.
67. Turritella incrassata, *Sow.*	*	*	
68. Natica cirriformis, *Sow.*	*		
69. —— crassa, *Nyst*	*		
70. —— hemiclausa, *Nyst*	.....	*	
71. —— clausa, *Brod. & Sow.*	.....	*	*
72. —— Sowerbyi, *Nyst*	.....	*	
73. Bulla lignaria, *Linn.*	*	*	*
74. —— cylindracea, *Penn.*	*	*	*
75. Cancellaria umbilicaris, *Brocc.*			
76. —— coronata, *Scacchi*	*	*	
C. varicosa, Phil.			
77. Fusus alveolatus, *Sow.*	*	*	
78. —— contrarius, *Gmel.*	.....	*	*
79. —— clathratus?, *Lamk.*			
80. —— corneus, *Sow.*	*	*	*
81. —— echinatus, *Sow.*	.....	*	*
Murex muricatus, Mont.			
82. Pleurotoma intorta, *Brocc.*	.....	*	
83. —— turricula, *Brocc.*	.....	*	
84. Rostellaria pes pelicani, *Linn.*	*	*	*
85. Buccinum Dalei, *Sow.*	*	*	*
B. crassum, Nyst.			
86. —— flexuosum?, *Brocc.*	.....	*	
87. —— elegans, *Sow.*	.....	*	
88. —— reticosum, *Sow.*	.....	*	
89. —— undatum, *Linn.*	*	*	*
B. tenerum, Sow.			
90. —— propinquum, *Sow.*	.....	*	
91. —— labiosum, *Sow.*	*	*	
92. Cassidaria bicatenata, *Sow.*	*	*	
93. Ringicula buccinea, *Brocc.*	*	*	
94. Cypræa europæa, *Gmel.*	*	*	*
	71	76	46

In the above list of 94 species it will be observed, by reference to the first two columns, that all but four of them are common to the Crag of Suffolk, and that 76 occur in the red crag, and 71 in the older or coralline crag. The proportion of recent species, as given in the third column, is 46, or nearly half of the whole, rather a smaller proportion than in the yellow crag, as shown in Tables II. and III.

3. *Glauconiferous Crag* or *Crag Noir. Lower Antwerp Crag.*—It has hitherto been the opinion of the Belgian geologists that the glauconiferous crag, or the dark green shelly sand of Antwerp, was considerably older than the two preceding groups, departing much farther in its fauna from that of the existing seas, and containing many shells common to older tertiary formations.

When I submitted a small collection of specimens which I obtained myself from this bed, consisting of the more abundant and therefore

most characteristic fossils, to Mr. Searles Wood, on my return from Belgium, he came to a different conclusion, which induced me to examine more critically the evidence furnished to me on this point by M. de Wael.

In the following Table I have enumerated all the species named in M. de Wael's MS. lists which could be distinctly recognized, whether by the aid of specimens in my own collection (chiefly presented to me by M. de Wael), or by the figures of M. Nyst, and have only omitted a small number respecting which M. de Wael has himself expressed doubts. The results will be given at the conclusion of the annexed Table.

TABLE V.

Shells from the Glauconiferous or Lower Crag of Antwerp (Crag noir), *in the collection of M. Norbert de Wael.*

		Cor.	Red.	Recent.
1. Corbula gibba, *Oliv.*	common.	*	*	*
2. —— (Poromya) granulata, *Nyst*	very rare.	*	.....	*
3. —— Waelii, *Nyst* *Neæra costellata*?, Forbes and Hanley.	rare.	.....	.....	*?
4. Mactra striata, *Nyst* *M. elliptica*, Brown.	common.	*	*	*
5. Erycina ambigua, *Nyst*	rare.	*	*	
6. Syndosmya prismatica, *W. Wood*	common.	*	.....	*
7. Saxicava arctica, *Linn.*	common.	*	*	*
8. Donax fragilis, *Nyst*	very rare.			
9. Lucina radula, *Montag.*	common.	*	*	*
10. Diplodonta dilatata, *Phil.*	common.	*	*	*
11. Astarte radiata, *Nyst* *A. gracilis*?, Münst.	common.	*		
12. —— minuta, *Nyst*	rare.			
13. —— Omalii, *Lajonk*	very rare.	*	*	
14. Venus multilamellata, *Sow.* *V. turgida*, Sow.	common.	*	*	*?
15. —— incrassata, *Sow.*	rare.			
16. Cardium turgidum, *Brander*	rare.			
17. Isocardia lunulata, *Nyst*	rare.	*	*	*?
18. Cardita squamulosa, *Nyst*	rare.	*	*	
19. —— corbis, *Phil.*	very rare.	*	*	*
20. —— orbicularis, *Sow.*	rare.	*	*	
21. Nucula depressa, *Nyst*	....	*		
22. —— Philippiana, *Nyst* *N. tenuis*, Phil. *N. pygmæa*, Goldf.	common.	*	.....	*
23. —— Westendorpii, *Nyst*	rare.			
24. —— Hasendonckii, *Nyst*	rare.			
25. Limopsis aurita, *Brocc.* *L. sublævigata*, Nyst.	.....	*		
26. —— decussata, *Nyst* *Trigonocœlia pygmæa*, Phil.	very rare.	*		

TABLE V. (continued).

		Cor.	Red.	Recent.
27. Pectunculus glycimeris, *Lamk*.....	very common.	*	*	*
28. Arca diluvii, *Lamk.*	very rare.	.....	.....	*
29. —— pusilla, *Nyst*.....	very rare.	*	.....	*
30. Mytilus sericeus, *Goldf*.....	very rare.	*		
31. Pecten Lamalii, *Nyst*	common.	*	.....	*
P. Bruei, Payr.				
32. —— maximus, *Linn.*	very rare.	*	*	*
P. jacobæus, Lamk.				
33. Ostrea cochlear?, *Poli*	very rare.	.....	.....	*?
34. Dentalium costatum, *Sow.*	rare.	*	*	*
35. —— entale, *Linn*.....	rare.	.....	.....	*
36. Patella virginea?, young, *Müll.* ...	rare.	.....	*?	*?
Ancylus compressus, Nyst.				
37. Calyptræa sinensis, *Linn*.....	rare.	*	*	*
38. Trochus papillosus, *DaCosta*	.....	.....	*	*
39. Solarium turbinoides, *Nyst*	rare.	*		
40. Scalaria lamellosa, *Brocc*.....	.....	*		
S. fimbriosa, Wood.				
41. Turritella incrassata, *Sow.*	.....	*	*	
42. Eulima subulata, *Montag.*	rare.	*	.....	*
43. Tornatella elongata, *Sow.*	very rare.	*		
44. —— striata, *Sow.*	.....	*	*	*
45. Pyramidella læviuscula, *S. Wood*...	rare.	*		
P. terebellata, Nyst.				
46. Natica Sowerbyii, *Nyst*.....	common.	*	*?	
47. —— crassa, *Nyst*	rare.	*		
48. Bulla cylindracea, *Penn.*	common.	*	*	*
49. —— constricta, *Sow.*	common.			
50. —— utricula, *Brocchi*	rare.	.....	.....	*
51. —— acuminata, *Brug.*	rare.	*	.....	*
52. Cancellaria varicosa, *Brocchi*	very rare.	*	*	
53. —— minuta, *Nyst* (? young of *C. planispira*)	rare.			
54. —— Michelinii, *Bellardi*	very rare, one individual.			
55. —— evulsa, *Brander*	very rare, one individual.			
56. Pleurotoma turricula, *Brocc.*	.....	.....	*	
57. —— dubia, *Crist*.....	very rare.			
58. —— cheilotoma?, *Bast.*	very rare.			
59. —— crenulata, *Bast.*	rare.			
P. Stoffelsii, Nyst.				
60. —— intorta, *Brocchi*	very rare.	.....	*	
61. Typhis cuniculosus, *Duchastel*	rare.			
62. Cassidaria bicatenata, *Sow.*	very rare.	*	*	
63. Buccinum prismaticum, *Brocc*.....	rare.	*	.....	*
64. Ringicula buccinea, *Brocc.*	common.	*	*	
65. Cypræa europæa, *Gmel.*	very rare.	*	*	*
		42	28	30

Several species of *Foraminifera* (*Nodosaria*, &c.) and several *Bryozoa* are also in M. de Wael's collection from this deposit.

Of the above 65 species of fossil mollusca, all but 16 are found in the Suffolk Crag. This number of exceptions, however, is greater than in the former lists. Most of them are marked as very rare by M. de Wael, and several of these are Rupelmonde Clay species, which may have been washed out of that older formation, such as *Cancellaria evulsa*, *Typhis cuniculosus*, and *Venus incrassata*. In regard to *Cardium turgidum*, a Barton shell, I had no means of comparing it with British specimens.

The proportion of coralline crag shells is 42 out of the 65 species, while there are only 28 common to the red crag. This preponderance of coralline crag species is in favour of the somewhat greater antiquity of the *crag noir*. The proportion also of recent species, 30 in 65, or about 46 per cent., is less than in the upper and middle crag of Antwerp. This would indicate a period more remote from our times, if we could feel sure that several of the extinct species, which are so extremely rare, have not been derived from older beds.

On comparing Tables III. and IV., it will appear that 30 species are common to the *crag gris* and *crag noir*, which, when we consider the total number of known species as fragmentary representations of the marine fauna to which each respectively belongs, indicates a very close approximation in age for the beds in question.

Table VI.

Showing the number of fossil species of Mollusca in the three divisions of the Antwerp Crag, and their relation to the Suffolk Crag and Recent fauna.

	Number of species.	Coralline.	Red.	Recent.
Upper or yellow crag of Calloo*	66	46	59	37
Upper or yellow crag of Steuvenberg†	52	39	37	31
Upper crag of Calloo and Steuvenberg united (Tabs. II. III.)	81	56	68	46
Middle crag‡	94	71	76	46
Lower crag§	65	42	28	30

§ 4. *Sands and Iron-sandstone of Diest* (B. 2. Table I. p. 279). *Système Diestien* of M. Dumont.

The series of which I have next to speak has been named by M. Dumont from the town of Diest, about thirty miles N.E. of Brussels, where the strata are of considerable thickness, but where they have yielded as yet no fossils. They consist for the most part of ferruginous sands and beds of a brown iron-sandstone, with occasionally quartzose sands abundantly mixed with green grains, and sometimes of a dark green or bright green glauconiferous sand.

* See Table II. † See Table III. ‡ See Table IV. § See Table V.

On the whole, in mineral character and aspect, they reminded me much of the ferruginous division of the Lower Green Sand in the South-east of England. Occasionally flint-pebbles are intermixed, and sometimes concretions of hydrate of iron are conspicuous. In several localities thin beds of clay separate the sands. I observed cross or false stratification on a large scale in these beds east of Louvain.

I found the hydrate of iron or limonite exceedingly abundant about two miles west of Louvain, on the road leading to Brussels, in the hill called "Montagne de Fer," where bright green grains are mixed with the quartzose sand.

The only spot where organic remains have been as yet observed is three miles east of Louvain, near Kesseloo, a place which I visited in company with M. Nyst, and where we collected casts of a species of *Turbinolia?*, tolerably abundant. In the same locality casts of the *Terebratula grandis* of Blumenbach (*T. variabilis*, Sow.) have been discovered. From the occurrence of this shell, a species very characteristic of the crag of England, together with casts of other genera, M. Nyst inclined many years since to the opinion that the Diest sands belonged to the crag. I have shown the casts in question, presented to me by M. Nyst, to Mr. Davidson, whose accurate knowledge of the Brachiopoda is well known, and he entertains no doubt of the correctness of the determination of this large Terebratula, not only from the form of the shell, but from the impressions of the peculiar processes which are so prominent in the interior. *Terebratula grandis* occurs in the Coralline and Red Crags of Suffolk, and I have seen it in extraordinary abundance in the crag of St. George de Bohon, near Carentan, in Normandy.

In M. Dumont's Report of 1839 I find the Diest sands given as next below the Campinian or Antwerp crag series, and he cites casts of Antwerp shells, *Pectunculus variabilis*, Sow. (*P. pilosus* or *P. glycimeris*, Linn.), and a supposed fragment of *Solen ensis*, as having been found by M. Van Beneden. All evidence of relative age, derived from position, seems to be wanting, or is confined to the fact that the Diest sands overlie the Bolderberg beds to be mentioned in the next section. Without the aid of the organic remains, we could not have decided whether the Diest sands were allied to the Antwerp crag, or to the Bolderberg deposit, or were quite independent of both. Whether they are more nearly related to the *Crag noir*, or to any other of the Antwerp crags before mentioned, is as yet uncertain.

The Diest sands are very conspicuous in Belgium and French Flanders, as forming the capping of hills throughout a great part of the country where the tertiary strata occur. I first saw them at Cassel, near Dunkirk, capping the chain of hills which extends from Cassel into Belgium. On Mont Noir, in particular, the mass crowning the hill consists partly of gravel with a ferruginous cement, and exhibits hollow tubular concretions of hydrate of iron, which in detached masses, as I saw them lying in a gravel-pit, resembled a pile of cannons, or a heap of large iron cylinders used for gas-pipes,

placed horizontally one upon the other. The following list of the casts of fossils from the Diest sands, however imperfect, may at least serve to show the present scanty state of our knowledge of this deposit.

Fossils from the Diest Sands of Kesseloo, near Louvain.

1. Terebratula grandis, *Blum.*
   T. variabilis, Sow.
   T. Sowerbyi, Nyst.
   T. maximus, Charlesworth.
2. Solen ensis ?, *Linn.*
3. Syndosmya prismatica ?, *W. Wood.*
   Ligula donaciformis ?, Nyst.
4. Axinus ?
5. Mactra ?
6. Pectunculus.
7. Cardium.
8. Calyptræa.
9. Natica.
10. Trochus.
11. Buccinum.
12. Fusus.
13. Cerithium.
14. Terebra.
15. Rostellaria.
16. Turbinolia ?

§ 5. *Bolderberg Sands* (C. Table I. p. 279). *Système Bolderien* of M. Dumont.

Between Diest and Hasselt, and about forty miles E.N.E. of Brussels, a small ridge, running nearly N.E. and S.W., and rising to the height of about 50 feet above the plain, and 200 feet, or rather less, above the level of the sea, is called the Bolderberg (see Map). It is situated about five miles N.W. of Hasselt, and its summit is formed of the sands of Diest, already described, below which are some beds of gravel and sand, of small thickness, in which the fossils exhibit a marine fauna, quite distinct from that of the Antwerp crag on the one hand, and that of the Limburg or Kleyn Spawen series on the other.

Fig. 1.—*Section of the Bolderberg.*

B 2. Diest sands and iron-sandstone. D. Limburg sands (*Rupelien* of Dumont).
C. Bolderberg sands and gravel.

In the cutting of a road which traverses the top of the ridge in a direction nearly east and west, and in other openings in the slope of the hill, I saw—

1. The ferruginous sands of Diest, with thin pipes of irony sandstone, in horizontal beds; the whole about 10 or 12 feet thick.
2. Next below, a light green glauconite and layers of brown sand, with mica and quartz grains; 2 feet.
3. A bed of gravel, occasionally cemented into a conglomerate by iron, with numerous fragmentary and some entire shells—this being the principal shell-bed of the Bolderberg formation; 6 inches.
4. Ferruginous and whitish sands; 20 feet
5. Whitish sand and pebbles, with some shells, mostly in fragments, and with numerous large *Ostreæ*; occasionally cemented into a conglomerate; 6 inches?

I may observe that all the shells occur in two beds, the united thickness of which scarcely exceeds a foot, and the broken fragments mixed with pebbles cause them to resemble shells thrown up on a sea-beach.

In the yellow, white, and green sands which underlie these Bolderberg beds, no shells have been found. They are referred by M. Dumont to part of his Rupelian system, but were it not for the accidental preservation of the shells in the gravels Nos. 3 and 5, it would, I conceive, have been impossible to separate the "Bolderian" from the overlying "Diestian," or subjacent "Rupelian" strata. The occurrence of glauconite, which in some countries would furnish a mineral character of considerable use in distinguishing formations, is so universal in Belgium in every tertiary group as to afford no aid whatever.

In a visit of a few hours I obtained specimens of most of the shells hitherto discovered, and the Bolderberg is the only locality where any fossils of this peculiar fauna have been met with in Belgium. The following list of 46 Mollusca and Corals is compiled partly from my specimens, which M. Nyst examined and named, but chiefly from information supplied by M. Bosquet of Maestricht. A large part, however, of the remains are mere casts, and their determination is by no means as satisfactory as could be wished. The notes of interrogation express the doubts entertained by M. Bosquet or by myself on the subject.

List of Fossil Shells and Corals from the Bolderberg near Hasselt.

1. Panopæa.
2. Corbula pisum, *Sow*
3. —— planulata, *Nyst.*
4. Mactra; sp. not determined.
5. Tellina; allied to *T. Benedenii* of the Antwerp Crag.
6. Donax Stoffelsii, *Nyst.*
7. Lucina astartea, *Nyst.*
8. Venus erycina, var. D., *Nyst.*
   V. erycinoides?, Bast.
9. —— chionoides?, *Nyst.*
10. —— rugosa, *Bronn*; so named for me by M. Nyst.
11. —— similis?, *Nyst.*
12. Venus; allied to *V. incrassata*, but more orbicular.
13. Astarte radiata?, *Nyst.*
14. Isocardia harpa, *Goldf.*
15. Nucula Ryckholtiana?, *Nyst.*
16. —— subglobosa?, *Philippi.*
17. Leda interrupta, *Bosq.*
    Nucula interrupta, Poli (Nyst).
18. Pectunculus pilosus, *Nyst.*
    P. glycimeris, Lamk.
19. Arca latisulcata, *Nyst.*
20. Pecten Sowerbyi, *Nyst.*
21. Ostrea; allied to *O. Meadei*, Sow., but different.

22. Phorus, sp. nov. ?
23. Turritella crenulata ?, *Nyst.*
24. —— incisa ?, *Al. Brongniart* (Nyst).
25. Natica ; resembling *N. patula,* Lamk.
26. —— olla, *Marcel de Serres.*
27. Sigaretus canaliculatus ?, *Sow.*
28. Cancellaria evulsa, *Brander.*
29. —— planispira, *Nyst.*
30. —— cassidia ?, *Borson.*
31. Angistoma politum, *Bosq.*
    Fusus politus, Bronn.
    Columbella.
32. Pleurotoma ramosa ?, *Bast.*
33. —— turris ?, *Lamk.*
34. —— Stoffelsii, *Nyst.*
35. —— denticula ?, *Bast.*
36. —— acuticosta ?, *Nyst.*
37. —— subcanaliculata ?, *Münst.*
38. —— filosa ? ; named for me by M. Nyst.
39. Cerithium crassum, *Dujard.* ; in M. Bosquet's collection.
40. Terebra pertusa, var. B., *Basterot.*
41. Eburna ; sp. not determined ; in M. Bosquet's collection.
42. Conus Brocchii ?, *Bronn.*
43. Ancillaria obsoleta, *Nyst.*
    Buccinum obsoletum, Brocchi.
44. Oliva Dufresnei, *Bast.* ; according to M. Nyst, but M. Bosquet doubts this identification, as the Bolderberg species is smaller and shorter, and has numerous striæ on the columella. It is the most abundant shell, though never quite perfect.
45. Flabellum Edwardsianum, *Bosq.*
46. —— avicula, *Nyst* (*Turbinolia avicula,* Michelotti).
47. Lunulites rhomboidalis, *Goldf.*

Although the above list comprises 47 species, so few of them are in a perfect state that we cannot well compare them as a whole with any recent or fossil fauna. Some of the supposed instances of agreement, such as the large *Ostrea* with *O. Meadii* of the 'Mineral Conchology' (an oolite species), are certainly erroneous. Nevertheless, we may at once affirm that we have here an assemblage of organic remains very distinct from the more modern crag of Antwerp or the more ancient Limburg beds.

Some of the species, such as *Isocardia harpa,* are at present peculiar to this locality. The *Oliva Dufresnei* ? is exceedingly plentiful. The genera *Oliva, Conus, Ancillaria,* and *Cancellaria* imply a warmer climate than that of the Antwerp crag.

In England we have no representative of the Bolderian formation of Dumont ; which may possibly be a Miocene deposit, approaching nearer in age to the faluns of Touraine than any other Belgian group. The climate seems to have been not unlike that which prevailed when the faluns of the Loire were deposited.

§ 6. *Limburg Tertiary series* (D. Table I. p. 279). *Systèmes Rupelien* and *Tongrien* of Dumont. Upper Eocene (Lower Miocene of some writers).

The tertiary strata of Belgium, which follow next in the descending series, or which underlie the Bolderberg sands already described, have been long known to palæontologists as the "Kleyn Spawen beds." At the village of Kleyn Spawen, in the ancient province of Limburg, west of Maestricht (see Map), and in the neighbourhood, they exhibit several marked subdivisions in regular order of superposition.

We are indebted to M. Hébert for having in 1849 pointed out the palæontological relation of the Limburg beds to the highest portion of the Parisian series, or, in other words, for having proved them to be the equivalents of strata which Cuvier and Brongniart originally styled "the second marine formation," comprising the *Grès de Fontainebleau* and the green marls with *Ostrea cyathula* which overlie the gypsum*.

After studying the Limburg beds with the advantage of the assistance of M. Bosquet, of Maestricht, I came to the conclusion that they may be most conveniently divided into three groups, of which the uppermost and the lowest are marine, and the middle fluvio-marine. The uppermost member has not afforded as yet in the Kleyn Spawen district, where it is of small thickness, more than thirty-two species of fossils, chiefly Mollusca and Entomostraca (see Table IX.); but at several places on the Scheldt near Antwerp, fifty miles E.N.E. of Kleyn Spawen, especially at Rupelmonde, Boom, Basele, and Schelle, it has yielded a large number of Mollusca. The names of these localities are familiar to the readers of Nyst's 'Coquilles tertiaires de Belgique,' and as I visited them all in the course of the summer I shall now describe them. (See Map, Pl. XVII. fig. 1.)

W. N. W. ?

1. *Rupelmonde Clay* (*Upper Limburg beds*). *Système Rupelien* of M. Dumont (D. 1. Table I. p. 279).

Rupelmonde.

Ascending the Scheldt from Antwerp (see Map), for a distance of about eight miles, to a point just above its junction with a small stream called the Rupel, we see on the left or north bank a line of cliffs half a mile long and about 100 feet high, adjoining the village of Rupelmonde. These cliffs consist chiefly of clay used for brick-making. At the top of the perpendicular precipice appears a bed of sand, varying from 5 to 20 feet in thickness, and below it, a mass of dark clay from 80 to 90 feet thick, under which I was informed whitish sandy strata have been pierced in boring.

The yellow sand at the top, usually about 16 feet thick, is stratified, and in it I found a few fragments of shells, apparently belonging to *Corbula planulata*, Nyst (*C. gibba*, Oliv.), and *Cyprina tumida*, Nyst, to which M. de Wael, of Antwerp, who has better specimens

* Hébert, Bulletin de la Soc. Géol. de France, 2 ser. vol. vi. p. 459, April 1849.

than mine, refers them. I also obtained fragments of an *Astarte*, apparently a crag species; so that I have little doubt of the correctness of M. de Wael's opinion, that this yellow sand represents the upper crag of Antwerp. The dark clay below resembles in mineral character the London clay, and contains, like it, septaria, or concretions of argillaceous limestone traversed by cracks in the interior and occurring in regular layers. The higher beds when dried are thinly fissile. Although a great number of fossil shells are annually collected by the workmen from this clay, I was scarcely able to find any after a search of several hours. The only species I saw *in situ* were *Nucula Deshayesiana*, a fragment of a *Dentalium*, and a Shark's tooth. But I obtained more than twenty species from the labourers.

Schelle and Boom.

The locality of Schelle is seen from Rupelmonde, being on the opposite bank of the Scheldt (see Map, Pl. XVII.). Here I found a mass of clay, from 50 to 60 feet thick, covered by yellow and whitish sand about 6 feet thick.

At Boom, which is on the same side of the river, the Rupelmonde clay is seen about 30 feet thick, covered, as in the other localities, with the yellow sand of the crag, and said to repose on whitish sand full of water, called by the workmen "drift." The great mass of clay at Boom is divided into two beds, at the point of junction of which is a layer of huge septaria. The lower bed, which contains balls of pyrites, is a stiffer clay, and is about 15 feet thick. The upper is more sandy. The only fossils which I myself found were *Pleurotoma Selysii*, *Nucula Deshayesiana*, and an *Anomia*? The shells are said to be dispersed through the clay. The only small species obtainable from the workmen in any locality is *Corbula pisum*, of which I saw no separate individuals, and which would I believe have been neglected but for the accident of their being frequently met with, aggregated together in flattened lenticular masses of pyrites. I suspect, therefore, that the Rupelmonde fauna would be much richer, if naturalists had not hitherto been almost entirely dependent, like myself, for their fossil mollusca on the workmen, who overlook all but the larger and more conspicuous species.

A description of forty-three species of shells from this formation, illustrated by figures of many of the most remarkable, was published, in January 1837, by M. de Koninck*.

M. Nyst has had the kindness to furnish me with a corrected list of those known to him in 1851. I procured specimens of all the more abundant of these, twenty-eight in number, on the spot, and have compared them, with the aid of Messrs. Morris and Edwards, with the very extensive collection of shells from the London Clay in the possession of the last-mentioned of these gentlemen. As the clay of Rupelmonde and Boom has been often regarded as contemporaneous with the London Clay, it was necessary to consult larger

* Mémoires de l'Acad. Roy. des Sciences, &c. de Bruxelles, tom. xi., Descript. des coq. foss. de l'argile de Basele, Boom, Schelle, &c.

collections of the English species than had hitherto been at the disposal of Belgian naturalists, which the kindness of Messrs. Morris and Edwards enabled me to accomplish.

Table VII.

List of Fossils from the Clay of Rupelmonde, Boom, and Schelle.

Names of species.	Observations.
1. Corbula pisum, *Sow.*	Occurs in England in the Upper Marine, Isle of Wight, in the clay of Barton, and in the Bracklesham beds.
2. Lutraria oblata?, *Sow.*	M. Nyst considers this as a doubtful identification from imperfect specimens, and proposes the name of *L. dubia.*
3. Erycina striatula, *Nyst.*	A shell imperfectly known.
4. Axinus Nystii, *Philippi.* *A. angulatus*, De Kon. *Lucina Goodhallii*?, Sow.	Mr. Morris observes that this shell is closely allied to *Lucina Goodhallii*, Sow. (Geol. Trans. 2 ser. v. tab. 8. fig. 7), a London Clay shell. It is probably, he says, only a local variety. It is distinguished by the deeper lunule, the more produced posterior folds, and divided surface.
5. Astarte Kickxii, *Nyst.*	
6. Venus incrassata, *Sow.*	M. Nyst does not feel sure of this identification, and I could not obtain specimens to compare with the British fossil.
7. Cardita Kickxii, *Nyst.* *C. globosa*, Sow.?	Perhaps a variety of *C. globosa.* It is intermediate, observes Mr. Morris, between two varieties of that shell from Barton in the collection of Mr. Edwards. The Belgian shell is more depressed, and the ribs are somewhat differently ornamented.
8. Leda Deshayesiana.	Larger and thicker than *Nucula amygdaloides* of the London clay, but in the young state much resembling the English shell.
9. Nucula archiacana, *Nyst.*	Very rare; only found as yet in Belgium.
10. — Chastelii, *Nyst.*	Also found at Hermsdorf, near Berlin.
11. Arca decussata, *Nyst.* *A. multistriata*, De Koninck.	A distinct species from *A. duplicata*, Sowerby, with which M. Nyst originally identified it.
12. Pecten Hoëninghausii, *Defr.*	
13. P. Ryckholtii, *Nyst.*	A small, newly discovered species, allied, as I learn from M. Nyst, to *Pecten obsoletus* and *P. sublævigatus*, but "with flatter valves and longitudinal striæ more distinct."
14. Ostrea paradoxa, *Nyst.*	
15. Dentalium Kickxii, *Nyst.*	
16. Phorus Lyellianus, *Bosq.* *Trochus agglutinans*, Nyst.	M. Nyst is now of opinion that this shell differs from *Trochus agglutinans*, Lamk. It has, he observes, a more conical spire.

TABLE VII. (continued).

Names of species.	Observations.
17. Scalaria, new species.	I met with this shell at Rupelmonde, and it will be figured and described in M. Nyst's Supplement. It comes very near to a London Clay species from Potter's Bar, near London, in Mr. Edwards's collection. It differs from *Scalaria costulata*, Nyst, pl. 38, fig. 6, in having nearly twice as many ribs (eighteen to twenty) in each whorl, in being larger, and having the whorls more symmetrically curved.
18. Actæon (Tornatella) simulatus, *Sow.*	Agrees with some varieties from Barton. It is smoother, and has the furrows less broad, than most of the individuals from the English strata.
19. Natica glaucinoides, *Sow.*	Identical with a Highgate or London Clay fossil; compared by Mr. Morris and Edwards.
20. Cancellaria evulsa, *Brander.*	The difference of this shell from that of Barton is too slight to constitute more than a variety. It agrees, says Mr. Morris, more closely with a Bracklesham form.
21. Fusus elongatus, *Nyst.*	Comes very near to a London Clay shell, but different.
22. — multisulcatus, *Nyst.* *F. lineatus*, Sow.?	Very close to *F. lineatus*, a Highgate shell, but the canal is straighter.—J. Morris.
23. — erraticus, *De Kon.*	
24. — Deshayesii, *De Kon.*	
25. — Koninckii, *Nyst.*	Allied to a Highgate shell, but different.
26. — Waëlii, *Nyst.* *F. regularis*, De Kon.	M. Nyst remarks that this species is different from *F. regularis*, Sow., with which it was formerly supposed to agree.
27. — Staquiezii, *Nyst.* *F. scalaroides*, De Koninck.	This small species, says M. Nyst, might be confounded with *F. aciculatus*, Lamk., but is different.
28. Pleurotoma Morrenii, *De Kon.*	Allied to an undescribed species from Highgate.
29. — crenata, *Nyst.* *P. subdenticulata*, Goldf.	Near to, if not a variety of, an unnamed Barton species.
30. — Selysii, *De Kon.*	Identified by Messrs. Morris and Edwards with a shell from Highgate.
31. — Koninckii, *Nyst.*	Very near to a London Clay shell from Potter's Bar, in Mr. Edwards's cabinet.
32. — Waterkeynii, *Nyst.*	Nearly allied to a Highgate shell.
33. — flexuosa?, *Goldf.* *P. acuminata*, Nyst.	M. Beyrich refers this species to *P. flexuosa*, Goldf. It is not *P. acuminata*, Sow.
34. — Bosquetii, *Nyst.*	This species has been supposed identical with *P. rostrata*, Brander, sp., but M. Nyst is now aware that it differs from it.
35. Murex Pauwelsii, *De Koninck.*	
36. — Deshayesii, *Nyst.*	Near to *M. cristatus*, Sow., a London Clay shell.

TABLE VII. (continued).

Names of species.	Observations.
37. Typhis cuniculosus, *Nyst.* *T. muticus*, Sow.?	Mr. Morris thinks this shell is probably a var. of *T. muticus*, Sow.
38. Triton argutum, *Brander.* *T. flandricum*, De Kon.	The Barton shell is a slight variety of this shell, but a variety from Highgate agrees with it.
39. Rostellaria (Chænopus) Sowerbyi, *Mant.* *Chænopus Margerini*, De Kon.	Agrees with the London Clay species, but larger in average size.
40. Cassidaria (Morio) depressa, *V. Buch.*	
41. — calanthica, *V. Buch.*	A rare species which I was unable to obtain.
42. Voluta semiplicata, *Nyst.*	
43. Nautilus ziczac, *Sow.* *Aturia ziczac*, Bronn.	De Koninck's figure agrees well with the London Clay shell. Only one individual ever found.

Several species of Entomostraca have also been met with in the Rupelmonde clay, and described by M. Bosquet*.

I obtained at Rupelmonde, Boom, and Schelle many Sharks' teeth, some belonging apparently to *Carcharodon heterodon*, Ag. of very large size. The following list comprises twelve species which I have in my collection.

Fossil Fish from Rupelmonde, Boom, and Schelle.

1. Carcharodon heterodon?, *Ag.*	One of the late Mr. Dixon's specimens from Bracklesham, now in the British Museum, agrees more closely than fig. 11–16, pl. 28, of Agassiz's 'Poiss. Foss.'
2. —— angustidens, *Ag.*	
3. Oxyrhina xiphodon, *Ag.*	
4. —— trigonodon, *Ag.*	
5. —— Desorii?, *Ag.*	
6. Otodus obliquus, *Ag.*	
7. Lamna elegans, *Ag.*	
8. —— cuspidata?, *Ag.*	
9. —— compressa?, *Ag.*	
10. —— Hopei, *Ag.*	
11. Galeocerdo minor, *Ag.*	
12. Notidanus primigenius, *Ag.*	

Of the 43 species of Mollusca above enumerated, no less than fifteen are supposed to be species found in English Eocene strata, viz. Nos. 1, 2?, 4, 6, 7?, 18, 19, 20, 22?, 29?, 30, 37, 38, 39, 43. It will be seen that four of these are given doubtfully, but, on the other hand, it is remarkable that several others, which are stated to be

* Mém. Couronn. de l'Acad. Roy. de Belgique, tom. xxiv.

nearly allied to undescribed London Clay species, come so near to them, that by some conchologists they might be thought identical. The affinity on the whole is more with the Barton Clay than with older members of the Eocene series. The general aspect of this fauna is so decidedly Eocene, that I am not surprised that M. Archiac, having no means near Antwerp of determining the relative position of the Rupelmonde clay, and knowing that MM. de Koninck and Nyst had identified one-fourth of the shells with English Eocene species, persisted even in 1848 in believing that it was part of the London Clay proper, which it resembles in mineral character, in the colour of its clay, its contained septaria, and its nodules of pyrites*.

The remains of fossil fish from Rupelmonde, as will be seen by the list, consist partly of London Clay and Calcaire grossier species, such as *Otodus obliquus*, *Lamna elegans*, and *L. compressa*, and partly of species cited by Agassiz as from the "molasse" of Switzerland.

Of the 28 species of shells which I myself obtained at Rupelmonde and the vicinity, the most abundant by far was *Nucula Deshayesiana*, and after it *Fusus multisulcatus*. The occurrence of seven species of *Pleurotoma*, some of them very common, is also a striking character, from which, and from a consideration of the whole of the data comprised in the foregoing list, my friend Professor E. Forbes infers that the clay of Rupelmonde was deposited in a sea at about the junction of his perilittoral and median zones of depth, or between 15 and 25 fathoms, probably nearer to 15 than to 25†.

It will be necessary to defer the consideration of the true age of the Rupelmonde Clay, until I have described the tertiary strata of the province of Limburg.

2. *Tertiary Strata in the neighbourhood of Kleyn Spawen, near Maestricht. Limburg Tertiaries.*

I have already alluded to the services rendered by MM. de Koninck and Nyst to the palæontology of Belgium by their description of the Rupelmonde fossils. The greater part of the Kleyn Spawen Mollusca have also been figured and described by M. Nyst, while M. Bosquet has recently given us an able account of the Entomostracous Crustaceans of the same district. The last-mentioned naturalist has

* Archiac, Hist. des Progr. tom. ii. p. 498.

† As Professor Forbes has recently modified his nomenclature of the zones of depth, in order to render his terms more applicable to the seas of all climates and all parts of the globe, I give the subjoined explanation of his new names as used in this memoir:—

Marine Zones of Depth, according to Prof. E. Forbes, 1852.

Names.	*Depths.*
Littoral zone	Between tide-marks.
Perilittoral zone { Upper or Laminarian division / Lower }	0 to 15 fathoms.
Median (or Coralline) zone { Upper Median / Lower Median }	15 to 30 „ / 30 to 50 „
Infra-median zone	15 to 100 „
Abyssal zone	100 to „

also laboured successfully in distinguishing the fossils of the several strata, observing which are peculiar to each, and which of them common to different members of the series, so that after I had visited the principal localities in his company, I was able to make myself master of a great body of information which it would have required years of unassisted labour to acquire. In tracing the subdivisions of the strata from one locality to another, and in identifying them in different places by aid of mineral character, we had the advantage of having been preceded by M. Dumont, whose patient and conscientious labours in constructing the map of Belgium cannot be too highly estimated. The task of unravelling the geological relations and geographical limits of the several groups in such a region is attended with no ordinary difficulties, in consequence of the frequent dearth of organic remains, and on account of a deep and almost continuous covering of loess. The resemblance to the older strata, moreover, of some deposits of loess, formed at the expense of denuded tertiary beds and containing the same fossils, adds greatly to the confusion.

After visiting Bergh, Vieux Jonc, Hoesselt, and Lethen near Kleyn Spawen (see Map, Pl. XVII. fig. 4), and the villages of Neerepen and Grimittingen, places familiar to the student of Nyst's work on the fossil shells of Belgium, and after considering the data liberally supplied to me by M. Bosquet, I thought it most useful, at least as a provisional classification, to divide the Limburg tertiaries into Upper, Middle, and Lower (D 1, D 2, and D 3, Table I. p. 279), the first and last being marine, and the middle a fluvio-marine deposit.

Table VIII.

Limburg Beds near Kleyn Spawen.

		Thickness.
Upper (marine) ...	Nucula-loam ("couche argilo-sableuse à Nucules," Bosquet)	3 feet.
Middle (fluvio-marine)	*a.* Bergh sands	14 „
	b. Yellowish sands	6 „
	c. Green marls	36 „
Lower (marine)...	Glauconiferous sandy clay, or *Ostrea ventilabrum* bed	20 „

The uppermost bed of the above Table, called "the Nucula loam," at Bergh is a mixture of sand and clay, in which the twenty-one species of Mollusca and eleven species of Entomostraca, enumerated in the second column of asterisks in Table IX. p. 312, occur. The *Nucula Lyelliana*, Bosq., is the most common shell of this bed, though difficult to obtain entire, owing to its fragile condition. All the other shells are rare except the *Corbulomya complanata*, which is the only one of the whole not decidedly marine. Next to *Nucula Lyelliana* the *Cytheridea Mulleri*, Bosq., is the commonest fossil. In regard to the probable depth of the sea, Prof. E. Forbes supposes it to indicate the lower part of his perilittoral zone.

Of the twenty-one species of Mollusca the following twelve species are common to this bed and to the clay of Rupelmonde, Boom, &c.,

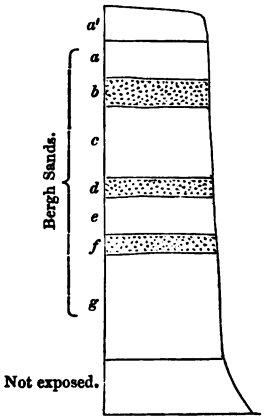
near Antwerp, already described, which (allowing for the small number of species in each) affords decisive palæontological evidence of their contemporaneous origin:—

Axinus Nystii.
Venus incrassata.
Natica glaucinoides.
Fusus elongatus.
Pleurotoma crenata.
—— flexuosa.
Murex Deshayesii.
Typhis cuniculosus.
Triton argutum.
Tritonium flandricum.
Rostellaria (Chænopus) Margerini.
Cassidaria depressa.
Voluta semiplicata.

Of the eleven species of Entomostraca above referred to, several are common to Rupelmonde, Boom, &c.

Next in the descending series we enter on the Middle Limburg beds, or the Bergh sands, *a*, Table VIII. By reference to the accompanying section, fig. 2, it will be seen that the first fossiliferous bed, *b*,

Fig. 2.—*Section of the Bergh Sands* (*a*, Table VIII.) *at Bergh, near Kleyn Spawen.*



	ft.	in.
a'. Nucula-loam	2	0
a. White sand without shells	2	0
b. Pectunculus-bed	1	6
c. White sands without shells	4	0
d. Shelly sand with *Cerithia*	0	6
e. Sand without shells	1	6
f. Shelly sand with *Cerithia*	1	0
g. White sand with few shells (*Cyprina Nystii*).		

of this division is called the Pectunculus-bed, from the extraordinary abundance in it of *Pectunculus fossilis*, Kon. (*P. terebratularis*, Lamk.). The following are the shells which have been met with:—

Fossils of the "Pectunculus-bed" at Bergh, near Kleyn Spawen.

Corbula Henckeliusiana.
Astarte Henckeliusiana (2).
—— trigonella.
Lucina tenuistria.
Cyprina islandica?
—— Nystii.
Venus lævigata (1).
—— incrassata.
Cardita Omaliana.
Pectunculus fossilis (6).
—— pulvinatus (2).
Limopsis Goldfussii (1).
Pecten Hoëninghausii (2).
—— Deshayesii.
Dentalium acutum (1).
Infundibulum striatellum.
Trochus Kickxii.
Natica hantoniensis.
Voluta Rathieri.

Myliobates.
Lamna contortidens.
—— cuspidata.

The seven species to which numbers are appended are the most common, and the numbers indicate the relative abundance of individuals according to M. Bosquet's observations. From the above data Professor Forbes infers that this Pectunculus-bed was probably formed at the junction of his perilittoral and median zones, or at the depth of from 15 to 20 fathoms. There is an absence here of *Cerithia* and other brackish and freshwater species.

The next fossiliferous bed (*d*, section, fig. 2), separated from the former by 4 feet of white sand without shells, is only 6 inches thick. It consists of a shelly sand with *Cerithia*, below which is another bed of sand without shells, and then a second layer of shelly sand with *Cerithia* (*f*, fig. 2). The shells in the two beds (*d* and *f*) are almost identical, but their proportional numbers differ slightly.

Fossils in Beds d and f, White Shelly Sands with Cerithia, at Bergh.—M. Bosquet.

	"*d*"	"*f*"		"*d*"	"*f*"
Corbula pisum	1	1	Pectunculus pulvinatus	1	1
Corbulomya triangula	2	3	Pecten Hoeninghausii	1	1
—— complanata	1	1	Paludestrina Draparnaudii	2	3
Astarte Henckeliusiana	1	1	Rissoa ? Chastelii	2	3
Cyrena semistriata	2	3	—— plicata	1	1
Lucina striatula	1		Rissoina Nystii	2	3
—— Thierensii	2	2	Cerithium subcostellatum	3	4
Venus incrassatoides	1	1	—— elegans	1	2
—— Kickxii	1	2	Pleurotoma belgica	1	1
Cardita Omaliana	1	1	Buccinum Gossardii	1	1
Cardium tenuisulcatum	1	1	Voluta Rathieri	1	1
Limopsis Goldfussii	2	3	Cytheridea Mulleri	1	1
Pectunculus fossilis	1	1			

The numbers appended denote the relative abundance of the several species, *Cerithium subcostellatum* (*C. plicatum*, Lamk.) being the most common. It will be observed that the freshwater and brackish water species are represented by a larger number of individuals in *f*, or in the lower bed. Prof. E. Forbes infers that these strata were formed in the upper part of his perilittoral zone, or in depths varying from low tide-mark to 6 or 7 fathoms.

In the Bergh sands the following six species are often much rolled: *Cyrena semistriata*, Desh., *Venus incrassatoides*, Nyst, *Pyramidella cancellata*, Nyst, *Rissoa plicata*, Desh., *Cerithium elegans*, Desh., and *Cerithium subcostellatum*, Schloth. But M. Bosquet remarks that some individuals even of these species are so perfect as to appear to have lived on the spot, and that there is no ground for inferring that such species were washed out of older beds, or that they did not inhabit rivers or estuaries communicating with the sea in which the white sands of Bergh were formed.

Beneath "*f*" of section, fig. 2, are white sands several feet thick, without fossils, except that a few specimens of *Cyprina Nystii* have been met with; and there is then a break in the section at Bergh at the place of the yellow sands (*b*, Table VIII. p. 304) which occur at Kleyn Spawen and Vieux Jonc, interposed between the white sands of Bergh (*a*, Table VIII.) and the green marls (*c*) of the same table.

Fossils of b, Table VIII., *or Yellowish Sands of Kleyn Spawen, in the collection of M. Bosquet.*

Panopæa Hebertiana, *Bosq.*
Corbulomya complanata, *Nyst.*
—— triangula, *Nyst.*
Corbula pisum, *Sow.*
Erycina neglecta, *Nyst.*
Psammobia rudis, *Lamk.*
Tellina Hebertiana, *Bosq.*
Lucina Thierensii, *Héb.*
—— tenuistria, *Héb.*
—— striatula, *Nyst.*
Cyrena semistriata, *Desh.*
Venus Kickxii, *Nyst.*
—— incrassatoides, *Nyst.*
Limopsis Goldfussii, *Bosq.*
Pectunculus terebratularis, *Lamk.*
Mytilus fragilis, *Nyst.*
—— Faujasii, *Al. Brong.*
Trochus striatellus, *Bosq.*
Paludestrina Draparnaudii, *Bosq.* (1)
Paludestrina pupa, *Bosq.*
Rissoina Nystii, *Bosq.* (1)
Rissoa ? Chastelii, *Bosq.* (1)
—— plicata, *Desh.* (1)
Turbonilla lævissima, *Bosq.*
Pyramidella cancellata, *Nyst.*
Nerita concava, *Sow.*
Natica glaucinoides ?, *Sow.*
Pleurotoma costellaria, *Duchast.*
Cerithium elegans, *Desh.* (3)
—— subcostellatum, *Schlt.* (6)
C. plicatum, Lamk.
—— incrassatum, *Merian.*
—— lima, *Desh.*
Buccinum Gossardii, *Nyst.*
—— suturosum, *Nyst.*
Cytheridea Mulleri, *Bosq.* (1)
—— Williamsoniana, *Bosq.*
Cythere Jurinei, *Münster.*

It will be seen that the only abundant shells in *b*, Table VIII., are fresh or brackish water species, and that *Cerithium subcostellatum* is the most frequent. According to Professor Forbes, this bed was formed in a shallow part of the perilittoral zone.

Next in the descending order are the green marls and clays, *c*, Table VIII., the Upper Tongrian of Dumont, which occur below the yellowish sands (*b* of the same Table). Their thickness at Lethen, Vieux Jonc, Hénis, and other localities which I visited is considerable (not less than 36 feet at Lethen), and they appear to indicate many oscillations of the water from a fresh to a brackish state. Sometimes, for example, a thin bed occurs almost exclusively characterized by *Venus incrassatoides* and *Lucina Thierensii*, then a layer with *Cyrena semistriata*, then another with *Cerithia*. I found occasionally at Lethen a well-rounded flint-pebble in the midst of these green clays and marls.

In the following list of seventeen species belonging to this subdivision, the relative abundance of the fourteen commonest species is expressed by numbers supplied by M. Bosquet. Prof. Forbes infers from them and the fossils generally that these clays were deposited in his perilittoral zone, in the neighbourhood of the influx of fresh water.

Fossils of the Green Marls, c, Table VIII. (*part of the Middle or Fluvio-marine Limburg Beds*).

Corbula pisum	2	Rissoa plicata	
—— complanata	1	——? Chastelii	1
Corbulomya triangula	2	Rissoina Nystii	2
Cyrena semistriata	4	Pyramidella cancellata	
Lucina Thierensii	2	Natica glaucinoides	1
Tellina Hebertiana	1	Cerithium subcostellatum	5
Venus incrassatoides	5	—— elegans	3
Trochus striatellus		Cytheridea Mulleri	6
Paludestrina Draparnaudii	2		

We now come to the Lower Limburg or Lower Tongrian beds, consisting of clayey greensand 20 feet thick, to which the 108 fossils enumerated in the "Lower" column of Table IX. p. 312, belong, and in which *Ostrea ventilabrum* is everywhere a common and conspicuous fossil. The uppermost beds of this deposit, which I saw at Lethen and at Grimittingen, where they are close to the green marls (*c* of Table VIII. above mentioned), are characterized, observes M. Bosquet, by the abundance of *Turritella crenulata*.

Upper portion of Lower Limburg, Table VIII. p. 304 (*Lower Tongrian*).
Most abundant species of Fossil Shells according to M. Bosquet.

	Relative abundance.		Relative abundance.
Corbula pisum, *Sow.*	1	Ostrea ventilabrum, *Goldf.* ...	6
Lucina gracilis, *Nyst*	1	—— cochlear, *Poli*	3
Pectunculus lunulatus, *Nyst* ...	1	Dentalium acutum, *Héb.*	1
Arca sulcicosta, *Nyst*	2	Turritella crenulata, *Nyst*	3

The lower beds of the same are seen at Hoesselt near Kleyn Spawen and at Grimittingen.

Most abundant species of Fossil Shells in the lower portion of the fossiliferous Lower Limburg beds.

	Relative abundance.		Relative abundance.
Corbula pisum, *Sow.*	1	Janira (Pecten) incurvata, *Bosq.*	1
Crassatella intermedia, *Nyst* ...	1	Ostrea ventilabrum, *Goldf.* ...	5
Isocardia transversa, *Nyst* ...	2	—— cariosa, *Desh.*	3
Cardita latisulca, *Nyst*	1	—— cochlear, *Poli*	2
Arca sulcicosta, *Nyst*	1	Dentalium acutum, *Hebert* ...	1
Mytilus Nystii, *Kickx*	3	Voluta suturalis, *Nyst*	1
Pecten reconditus, *Brander* ...	2		

Professor Forbes refers these lower beds, which are purely marine, to the upper part of his median (or coralline) zone. He supposes that the inferior beds indicate a muddy bottom, which was at a somewhat greater depth in the same zone than that in which the superior ones were formed.

It will be seen by consulting Table IX. p. 312, that the Lower Limburg beds out of 106 species of mollusca have no less than 68 peculiar to themselves, only 38 species passing upwards into the Middle and Upper Limburg divisions. All these 106 species are purely marine, except *Corbulomya complanata*, found at Lethen in the upper part of the bed.

The distinctness of so many of these Lower Limburg fossils from the species occurring in the beds immediately above, arises no doubt in a great degree from a difference in *stations*, or in the fauna of the the median as compared to that of the perilittoral zone. But the changes in time may also have been great during those ages when the sea and a river were contending for the occupation of the area in which the middle Limburg strata were thrown down.

3. *Micaceous Sands of Hénis, Geulem, Klimmen, &c.*

On the right bank of the Meuse opposite Maestricht, the most eastern locality where I saw the Limburg tertiaries, they consist of whitish and yellowish micaceous sands without fossils. I observed them at Geulem, about five miles N.N.E. of Maestricht. The uppermost part of the section in that place exhibits loess and gravel, 25 feet thick, below which is 20 feet of white and greyish sand, followed by yellowish sand with mica, 10 feet thick, and lastly Maestricht chalk. I learn from M. Bosquet, that at Klimmen, on the same side of the Meuse, near Fauquemont, are white sands in a similar position, about 30 feet thick, in which he found *Venus incrassata* and some other fossils ill-preserved, but none which showed distinctly whether these sands are referable to the Lower or Middle Limburg series.

I observed similar beds at Hénis, immediately below the green marls of the middle division (*c*, Table VIII. p. 304). The sands also at Predikheerenberg, near Louvain, mentioned by M. Dumont as underlying the Rupelmonde clay of that locality, may belong to the same division, but, in the absence of strata containing *Ostrea ventilabrum* and other characteristic lower Limburg shells, it seemed to me impossible to settle the true age of such sands.

4. *Relation of the Rupelmonde and Boom Clay to the Upper Limburg Beds.*

An important notice was read to the Royal Academy of Brussels by M. Dumont, in 1851, "On the geological position of the Rupelian clay*," in which he announced the discovery at Predikheerenberg and Lubbeck, near Louvain, of clay with septaria, precisely resembling in mineral character that of Rupelmonde and Boom, and containing several characteristic species of fossil shells, as *Leda Deshayesiana*, *Nucula Chastelii*, and *Astarte Kickxii*. This schistose clay reposes on sand, in which casts and impressions of fossils referred to *Pecten Hoëninghausii*, *Pectunculus fossilis*, Kon. (*P. terebratularis*, Lamk.), and *Cyprina Nystii*, all of them middle Limburg shells, have been met with.

I visited the localities myself, in company with M. de Koninck, and have no doubt that the dark schistose clay at Lubbeck and some neighbouring places corresponds to that of Rupelmonde. It is covered by the Diest sands, and rests on other sands which belong to some part of the Limburg beds below the "Nucula-loam" (Table VIII. p. 304); the state of decomposition, however, of the organic remains found in them makes it somewhat rash at present to assign to the sandy beds an exact position in the series.

The middle Eocene strata, or Brussels beds, are seen near the base of the hill of Predikheerenberg, not far from the village of Parc, and in the suburbs of the town of Louvain, near the Tirlemont gate.

* Acad. Roy. de Belgique, tom. xviii. no. 8. des Bulletins, lue le 2 Août 1851.

A. Rupelmonde.	Thickness. Feet.
1. Yellow crag	15
2. Rupelmonde clay, with *Leda Deshayesiana*, &c.	90
3. White sands (Middle Limburg sands?) pierced by boring...	Unknown.

B. Louvain.	Thickness. Feet.
1. Diest sands	4 to 20
2. Clay with *Leda Deshayesiana*, &c. ...	2 to 10
3. Sands with Middle Limburg fossils ...	40
4. Brussels beds, or Middle Eocene.	Unknown.

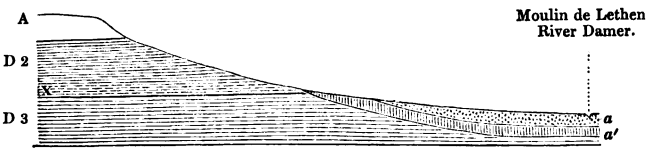
C. Bergh and Kleyn Spawen, Limburg.	Thickness. Feet.
1. Loess	15
2. Nucula-loam with many Rupelmonde fossils	3
3. Sands and green marl (Middle Limburg).	56
4. Lower fossiliferous Limburg beds with *Ostrea ventilabrum*	20

On comparing the accompanying three sections, A., B., and C., the nature of the evidence in favour of considering the Rupelmonde clay to be the equivalent of the Upper Limburg or "Nucula-loam" of Bergh, near Kleyn Spawen, may be readily appreciated. It will be necessary for the reader to bear in mind that the Louvain section, B., is geographically intermediate between A. and C.; Louvain being only twenty miles south-east of Rupelmonde, and forty miles west of Kleyn Spawen. The identity of the clays No. 2 in A. and B. is shown both by the similarity of their mineral character and contained septaria, and by the presence of *Leda Deshayesiana* in abundance. The intimate relation of the bed No. 2 in A. and C. is shown by the large number of fossil species common to both, as before stated, p. 304.

5. *On the Loess near Kleyn Spawen, and on the Denudation of the Limburg Tertiary strata.*

Before presenting the reader with a general Table of the Limburg fossils, and with such observations as they suggest, I must say a few words on the manner in which the Loess and associated alluviums occur near Kleyn Spawen, sometimes putting on the appearance of regular tertiary strata.

Fig. 3.—*Section at Lethen near Bilsen, Limburg.*



A. Loess of the ordinary character.
D 2. Middle Limburg series. Upper part, green marl; the lower, X, grey sand, and green clay and sand, unfossiliferous.
D 3. Lower Limburg beds. Sand with *Ostrea ventilabrum*.
a. Greenish sandy clay. } Modern alluvium.
a'. Yellowish sandy clay. }

Near Lethen, for example, the annexed section is seen on the slope of the ground towards the valley of the Damer. When I first examined, with M. Bosquet, the beds, *a*, *a'*, consisting of greenish clay and sand, and containing *Corbula pisum*, *Cerithium subcostellatum*, *Cyrena semistriata*, and many other Middle Limburg fossils, I sup-

posed them to be a part of the regular series, or Lower Limburg beds, but M. Bosquet made excavations after we parted, which proved the order of superposition to be as in the above section. • He also found, on washing the alluvial clay or loam, *a*, *a'*, that it included many Foraminifera of the Maestricht chalk, such as *Rosalina depressa*, D'Orb., *Siderolina calcitrapoides*, Lamk., &c.; also Bryozoa, from the same, of the genera *Vincularia*, *Idmonea*, *Pustulopora*, and others, besides several Entomostraca, in all twelve cretaceous fossils. These must have been brought down from the region between Tongres, Liege, and Maestricht, or from the upper sources of the Damer, where the Maestricht chalk exists, and the fossils were mixed up with those of the denuded tertiary strata. The waters of the Damer must have risen 40 or 50 feet above their present level to have deposited the more elevated part of these modern alluviums.

At Hoesselt a remarkable bed of pebbles, 1½ foot thick, occurs in an analogous position, composed of well-rolled flint-pebbles, with an abundance of large oysters (*Ostrea ventilabrum*) and other fossils. This gravel rests on the Lower Limburg sands; it is nearly horizontal, and does not follow the slope of the ancient valley, scooped out of the tertiary strata, which it has partially filled up. The shells which M. Bosquet has found in it belong to no less than 49 species, by far the greater part of them Middle or Upper Limburg species, and usually much rolled; whereas the Lower Limburg shells, especially the smaller species, have suffered very little. Some of the flint-pebbles in this gravel are 4 or 5 inches in diameter. At first sight the mixture of freshwater and brackish water shells with rolled marine species, reminded me of parts of the Woolwich pebble-beds belonging to the lower Eocene, near London.

At Grimittingen also, and at Neerepen, I met with pebble-beds overlying the Lower Limburg tertiaries, which M. Dumont refers to the age of the Loess. They contain *Cyrena*, *Pectunculus*, and various Middle Limburg shells, and some of them are with difficulty distinguishable from part of the regular series, which also, even where it is undisturbed, as at Lethen, includes rolled flint-pebbles, and, as in the case of the sands of Bergh, before alluded to (p. 306), rolled fossils.

At Neerepen, the task of drawing the line between the incumbent loess and the fluvio-marine tertiary beds is still more difficult. The two deposits are laid open to view in a deep lane. The loess in its upper part consists of a fine yellowish grey loam, as in the valley of the Rhine; and this was the only spot in Belgium where I found it to contain *Succinea oblonga*, which so generally characterizes it in the Rhine valley, and *Helix plebeia*? or *hispida*?. Still lower the same species of land-shells are again seen, in a bed in which entire *Cerithia* and other tertiary shells abound, so intimately blended, that no geologist visiting the district for the first time would suspect them to be of different ages. M. Bosquet found here an Elephant's tusk, 2 feet long, extending from the loess into the stratum full of *Cerithia* and tertiary shells. At a lower level is a pebble-bed, from 3 to 4 feet thick, containing *Corbula pisum*, *Pectunculus pilosus*, *Corbulomya triangula*, *Cyrena semistriata*, and several species of *Cerithia*. This

stratum had all the appearance of an undisturbed tertiary bed, but is probably, like that of Hoesselt, of later origin.

6. *Synoptical Tables of the Limburg fossils.*

The following synoptical Table of the organic remains of the Limburg tertiary strata has been communicated to me by M. Bosquet, and I have inserted a column for the Rupelmonde species, given more in detail in Table VII. A large portion of the Mollusca have been compared by me in London with British fossils, with the assistance of MM. Morris, Edwards, E. Forbes, and other eminent palæontologists.

Table IX.

Fossils of the Rupelmonde and Kleyn Spawen Beds, or of the Upper, Middle, and Lower Limburg Beds:—M. Bosquet.

The first column of asterisks refers to the fossils of the clay of Rupelmonde, Boom, &c. near Antwerp. The second, to the fossils of the "Nucula-loam," Table VIII. The third, to the fossils of *a*, *b*, *c*, Table VIII., or the white and yellow sands and green marls of Bergh, Kleyn Spawen, Lethen, &c., constituting the Middle or Fluvio-marine Limburg series. And the fourth column, to the fossils of the Lower Limburg, or "Ostrea ventilabrum beds."

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
Corallia.				
1. Turbinolia sulcata, *Lam.*	.....	.....	.....	*
2. Dendrophyllia amica, *Milne-Edw. & Haime*	.....	.....	.....	*
				2
Mollusca.				
1. Clavagella tibialis ?, *Lamk.*	.....	.....	.....	*
2. Pholas cylindrica ?, *Sow.*	.....	.....	*	
3. Solen ensis, var. *b*, minor, *Lamk.*	.....	.....	*	
4. Leguminaria papyracea, *d'Orbigny* (*Desh.*)	.....	.....	.....	*
5. Solecurtus compressus, *Nyst* ..... *Sanguinolaria compressa*, Sow.	.....	.....	*	*
6. —— appendiculatus, *Nyst* (*Lamk.*)	.....	.....	*	
7. Panopæa Hebertiana, *Bosq.* ..... *P. intermedia*, Nyst, non Desh.	.....	.....	*	
8. Mya angustata ?, *Sow.*	.....	.....	*	
9. Lutraria oblata ?, *Sow.* ..... *Thracia oblata*, Morris.	*			
10. Corbulomya complanata, *Nyst* (*Sow.*)	.....	*	*	*
11. —— triangula, *Nyst* (*Duchast.*)	.....	.....	*	
12. Corbula Henckeliusiana, *Nyst*	.....	.....	*	*
13. —— pisum, *Sowerby*	*	.....	*	*

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
14. Corbula striata, *Lamarck*	.....	.....	*	*
15. —— fragilis, *Nyst*..	.....	.....	.....	*
16. Crassatella intermedia, *Nyst*	.....	.....	.....	*
17. Astarte Henckeliusiana, *Nyst*	.....	.....	*	
18. —— Omalii, *Lajonk.*, var. D., *Bosquet*	.....	.....	*	*
19. —— trigonella, *Nyst*	.....	.....	*	
20. —— Bosquetii, *Nyst*	.....	.....	*	*
21. —— Kickxii, *Nyst*, var. B., *Bosquet*	*	.....	.....	*
22. —— plicatella, *Bosq.*	.....	.....	.....	*
23. Erycina neglecta, *Nyst*	.....	.....	*	
24. —— striatula, *Nyst*	*			
25. Ligula fragilis, *Bosq.*	.....	.....	*	*
26. —— brevis, *Bosq*	.....	.....	.....	*
27. Psammobia rudis, *Lamk.*	.....	.....	*	
28. Tellina Hebertiana, *Bosq.*	.....	.....	*	
29. Lucina gracilis, *Nyst*	.....	.....	.....	*
30. —— Thierensii, *Hébert*	.....	.....	*	
L. albella, Nyst.				
31. —— tenuistria, *Hebert*	.....	*	*	
L. uncinata, Nyst.				
32. —— lepida, *Bosq*	.....	.....	*	
L. divaricata, Nyst.				
33. —— striatula, *Nyst*	.....	.....	*	
34. Diplodonta apicalis, *Philip.*	.....	.....	.....	*
D. parvula, Nyst.				
35. Axinus Nystii, *Philip.*	*	*	.....	*
A. angulatus, De Kon.				
Lucina Goodhallii?, Sow.				
36. Cyrena semistriata, *Desh.*	.....	.....	*	
37. Cyprina Nystii, *Hébert*	.....	.....	*	
C. scutellaria, Nyst.				
38. —— islandica, var. *a*, *Nyst*?	.....	*	*	
39. Venus sublævigata, *Nyst*	.....	.....	.....	*
40. —— sulcataria, *Nyst*	.....	*	.....	*
V. Bosquetii, Hébert.				
41. —— lævigata, *Nyst* (*Lamk.*)	.....	.....	*	*
42. —— Kickxii, *Nyst*	.....	.....	*	
43. —— incrassata, *Sow.*	*	*	*	*
44. —— incrassatoides, *Nyst*	.....	.....	*	
45. —— Westendorpii, *Nyst*	.....	.....	*	
46. Cardium hippopæum, *Desh.*	.....	.....	.....	*
47. —— porulosum, *Brander*	.....	.....	.....	*
48. —— tenuisulcatum, *Nyst*	.....	.....	*	*
49. —— elegans, *Nyst*	.....	.....	.....	*
50. —— Raulini, *Hébert*	.....	.....	*	
51. —— scobinula, *Mérian*	.....	.....	*	
C. striatulum, Nyst.				

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
52. Isocardia transversa, *Nyst*	.....	.....	.....	*
53. —— multicostata, *Nyst*	.....	.....	.....	*
54. —— carinata, *Nyst*	.....	.....	.....	*
55. Cypricardia pectinifera, *Morr.* (*Sow.*)	.....	.....	.....	*
56. Cardita latisulca, *Nyst*	.....	.....	.....	*
57. —— Omaliana, *Nyst*	.....	.....	*	
58. —— Kickxii, *Nyst*	*			
C. globosa, Sow.?				
59. Leda Galeottiana, *Bosq.* (*Nyst*)	.....	.....	.....	*
60. —— Westendorpii, *Bosq.* (*Nyst*)	.....	.....	*	
61. —— Deshayesiana	*			
62. Nucula similis, *Sow.*	.....	.....	.....	*
63. —— subtransversa, *Nyst*	.....	.....	*	
64. —— Lyelliana, *Bosq.*	.....	*		
65. —— archiacana, *Nyst*	*			
66. —— Chastelii, *Nyst*	*			
67. Limopsis scalaris, *Bosq.* (*Nyst*)	.....	.....	.....	*
68. —— auritoides, *Bosq.* (*Galeotti*)	.....	.....	.....	*
69. —— Goldfussi, *Bosq.* (*Nyst*)	.....	.....	*	
70. Pectunculus fossilis, *De Koninck*	.....	.....	*	
P. terebratularis, Lamk.				
71. —— pulvinatus, *Nyst*, non *Lamk.*	.....	.....	*	
72. —— lunulatus, *Nyst*	.....	.....	.....	*
73. —— nummarius?, *Lamk.*	.....	.....	.....	*
74. Arca sulcicosta, *Nyst*	.....	.....	.....	*
75. —— decussata, *Nyst*	*			
A. multistriata, De Kon.				
76. Mytilus Nystii, *Kickx*	.....	.....	.....	*
77. —— corrugatus?, *Brongn.*	.....	.....	*	
78. —— fragilis, *Nyst*	.....	.....	*	
79. —— Faujasii, *Brongn.*	.....	.....	*	
80. Dreissena Basteroti, *Nyst* (*Desh.*)	.....	.....	*	
81. Pinna affinis?, *Sow.*	.....	.....	.....	*
82. Pecten reconditus, *Nyst* (*Brander*)	.....	.....	.....	*
83. —— corneus, *Sow.*	.....	.....	.....	*
84. —— Deshayesii, *Nyst*	.....	.....	*	
85. —— tigerinus, *Müller*, var. F.	.....	.....	*	
P. novemcostata, Bosq.				
86. —— Hoëninghausii, *Def.*	*	.....	*	*
Janira Hoëninghausii, Bosq.				
87. —— Ryckholtii, *Nyst*	*			
88. —— incurvatus, *Nyst*	.....	.....	.....	*
Janira incurvata, Bosq. (Nyst).				
89. Spondylus auriculatus, *Nyst*	.....	.....	.....	*
90. —— Buchii, *Philip.*	.....	.....	.....	*
91. Anomia orbiculata?, *Brocchi*	.....	.....	.....	*
92. Ostrea cochlear?, *Poli*	.....	.....	.....	*

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
93. Ostrea ventilabrum, *Goldf.*	.....	.....	.....	*
94. —— cariosa, *Desh.*	.....	.....	.....	*
95. —— gigantea, *Brander*	.....	.....	*	
96. —— bellovacina?, *Lamk.*	.....	.....	*	
97. —— paradoxa, *Nyst*	*			
98. Dentalium Kickxii, *Nyst*	*			
99. —— acutum, *Hébert*	.....	.....	*	*
D. grande, Nyst, non Desh.				
100. —— fissura, *Lamk.*	.....	.....	*	*
101. Emarginula Nystiana, *Bosq.*	.....	.....	*	*
102. Capulus cornu-copiæ, *Bronn* (*Defr.*)	.....	.....	*	*
103. Infundibulum striatellum, *Bosq.* (*Nyst*)	.....	*	*	*
104. —— lævigatum, *Bosq.* (*Desh.*)	.....	.....	*	
105. Solarium Dumontii, *Nyst*	.....	.....	.....	*
106. Phorus extensus?, *Pusch*	.....	.....	.....	*
107. —— Lyellianus, *Bosq.*	*	.....	*	
Trochus agglutinans, Nyst.				
108. Trochus Kickxii, *Nyst*	.....	.....	*	
109. —— striatellus, *Bosq.*	.....	.....	*	
110. Scalaria costulata, *Nyst*	.....	.....	*	
111. ——, nov. sp.	*			
112. Ampullaria mutabilis, *Nyst*, non *Brander.*	.....	.....	*	*
Globulus, Sow.				
113. Turritella crenulata, *Nyst*	.....	.....	.....	*
114. —— planispira, *Nyst*	.....	.....	.....	*
115. Paludestrina Draparnaudii, *Bosq.*	.....	.....	*	
Paludina, Nyst.				
116. —— pupa, *Bosq.* (*Nyst*)	.....	.....	*	
117. Rissoina Nystii, *Bosq.* (*Duchast.*)	.....	.....	*	
Melania Nystii, Nyst.				
118. Rissoa? Chastelii, *Bosq.*	.....	.....	*	
Paludina Chastelii, Nyst.				
119. Rissoa plicata, *Desh.*	.....	.....	*	
R. violacea?, Frémin et Desmar.				
120. —— Duboisii, *Nyst*	.....	.....	*	
121. —— succincta, *Nyst*	.....	.....	*	
122. Actæon (Tornatella) simulatus, *Sow.* (*Brander*)	*	.....	*	*
123. Turbonilla lævissima, *Bosq.*	.....	.....	*	
Tornatella acicula, Nyst, non Desh.				
124. —— spina, *D'Orbigny* (*Desh.*)	.....	.....	*	
125. Pyramidella cancellata, *Nyst*	.....	.....	*	*
126. Niso terebellata, *Bronn*	.....	.....	.....	*
127. Nerita concava, *Nyst* (*Sow.*)	.....	.....	*	
128. Natica glaucinoides, *Sow.*	*	*	*	
129. —— hantoniensis, *Sow.*	.....	.....	*	*
130. —— hemiclausa?, *Sow.*	.....	.....	*	

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
131. Sigaretus canaliculatus, *Sow.*	.....	.....	.....	*
132. Bulla Sowerbyi, *Nyst*	.....	.....	.....	*
133. —— utricula, *Brocchi*	.....	.....	.....	*
134. —— acuminata, *Brug.*	.....	.....	.....	*
135. —— constricta?, *Sow.*	.....	.....	*	
136. Limneus fabulum?, *Al. Brong.*	.....	.....	*	
137. Planorbis rotundatus?, *Brong.*	.....	.....	*	
P. corneus?, Drap.				
138. —— depressus, *Nyst*	.....	.....	*	
139. Cancellaria elongata, *Nyst*	.....	.....	.....	*
140. —— quadrata, *Sow.*	.....	.....	.....	*
141. —— evulsa, *Sow.* (*Brander*)	*	.....	*	*
142. —— granulata, *Nyst*	.....	.....	*	
143. Turbinella pyruliformis, *Nyst*	.....	.....	.....	*
144. Cordieria Delucii, *Bosq.* (*Nyst*)	.....	.....	.....	*
145. Fusus elongatus, *Nyst*	*	*	*	*
146. —— multisulcatus, *Nyst*	*	.....	*	*
F. trilineatus, Sow.				
147. —— Burdigalensis, *Bosq.* (*Baster.*)	.....	.....	.....	*
148. —— scalariformis, *Nyst*	.....	.....	.....	*
149. —— Deshayesii, *De Kon.*	*	*	*	
150. —— erraticus, *De Kon.*	*			
151. —— Koninckii, *Nyst*	*			
152. —— Waelii, *Nyst*	*			
F. regularis, De Kon.				
153. —— Staquiezii, *Nyst*	*			
F. scalaroides, De Kon.				
154. Pyrula decussata, *Bosq.*	.....	.....	.....	*
P. nexilis, Nyst, non Desh.				
155. —— elegans, *Lamk.*	.....	.....	*	
156. Pleurotoma turbida, *Nyst* (*Brander*)	.....	*	.....	*
157. —— crenata, *Nyst*	*	*	*	
P. subdenticulata, Goldf.				
158. —— Waterkeynii, *Nyst*	*	.....	*	*
159. —— belgica, *Goldf.*	.....	.....	*	
160. —— Bosquetii, *Nyst*	*	.....	*	*
161. —— conoidea, *Nyst* (*Brander*)	.....	.....	.....	*
162. —— Selysii, *De Kon.*	*	.....	.....	*
163. —— Dumontii, *Nyst*	.....	.....	.....	*
164. —— semi-colon?, *Nyst* (*Sow.*)	.....	.....	.....	*
165. —— acuticosta, *Nyst*	.....	.....	.....	*
166. —— costellaria, *Duchast*	.....	.....	*	
167. —— Morrenii, *De Kon.*	*			
168. —— Koninckii, *Nyst*	*			
169. —— flexuosa, *Goldf.*	*	*	*	
P. acuminata, Nyst (non Sow.).				

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
170. Cerithium elegans, *Desh.*	.....	.....	*	
C. margaritaceum, Nyst, non Brocchi.				
171. —— subcostellatum, *Schloth.*	.....	.....	*	
C. plicatum, Lamk.				
C. Galeottii, Nyst.				
172. —— incrassatum, *Merian*	.....	.....	*	
C. tricinctum, Nyst.				
173. —— lima, *Desh.*	.....	.....	*	
174. —— Henckeliusii, *Duchast.*	.....	.....	*	
175. Murex Deshayesii, *Duchast.*	*	*	*	*
176. —— fusiformis, *Nyst*	.....	.....	.....	*
177. —— brevicauda, *Hébert*	.....	.....	.....	*
M. tricarinatus, Nyst.				
178. —— Pauwelsii, *De Kon.*	*			
179. Typhis tubifer, *Montf.*	.....	.....	.....	*
180. —— cuniculosus, *Nyst*	*	*	*	*
T. muticus, Sow.?				
181. Triton argutum, *Brander*	*	*	*	*
T. flandricum, De Kon.				
182. Rostellaria ampla, *Brander*	.....	.....	.....	*
R. macroptera, Lamk.				
183. —— fissurella, *Lamk.*	.....	.....	.....	*
184. —— Sowerbyi, *Mant.*	*	*	*	
Chenopus Sowerbyi, Philippi.				
—— *Margerini*, De Kon.				
185. Cassidaria (Morio) depressa, *V. Buch*	*	*	*	*
186. —— ambigua, *Nyst*	.....	.....	.....	*
187. —— calanthica, *V. Buch*	*			
188. Buccinum Gossardii, *Nyst*	.....	*	*	*
189. —— desertum?, *Brander*	.....	.....	*	
190. —— suturosum, *Nyst*	.....	.....	*	
191. Conus Brocchii?, *Bronn*	.....	.....	.....	*
192. —— lineatus?, *Brander*	.....	.....	.....	*
193. Voluta suturalis, *Nyst*	.....	.....	*	*
194. —— cingulata, *Nyst*	.....	.....	.....	*
195. —— Rathieri, *Hébert*	.....	*	*	
V. depressa, Nyst, non Lamk.				
196. —— semigranosa, *Nyst*	.....	.. ...	.....	*
197. —— semiplicata, *Nyst*	*	*		
198. Terebellum fusiforme?, *Lamk.*	.....	.....	.....	*
199. Ancillaria canalifera, *Lamk.*	.....	.....	.....	*
200. —— buccinoides, *Lamk.*	.....	.....	... ..	*
201. Nautilus ziczac, *Sow.*	*			
Aturia ziczac, Bronn.				
	43	21	106	106

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
131. Sigaretus canaliculatus, *Sow.*	.....	.....	.....	*
132. Bulla Sowerbyi, *Nyst*	.....	.....	.....	*
133. —— utricula, *Brocchi*	.....	.....	.....	*
134. —— acuminata, *Brug.*	.....	.....	.....	*
135. —— constricta?, *Sow.*	.....	.....	*	
136. Limneus fabulum?, *Al. Brong.*	.....	.....	*	
137. Planorbis rotundatus?, *Brong.*	.....	.....	*	
P. corneus?, Drap.				
138. —— depressus, *Nyst*	.....	.....	*	
139. Cancellaria elongata, *Nyst*	.....	.....	.....	*
140. —— quadrata, *Sow.*	.....	.....	.....	*
141. —— evulsa, *Sow.* (*Brander*)	*	.....	*	*
142. —— granulata, *Nyst*	.....	.....	*	
143. Turbinella pyruliformis, *Nyst*	.....	.....	.....	*
144. Cordieria Delucii, *Bosq.* (*Nyst*)	.....	.....	.....	*
145. Fusus elongatus, *Nyst*	*	*	*	*
146. —— multisulcatus, *Nyst*	*	.....	*	*
F. trilineatus, Sow.				
147. —— Burdigalensis, *Bosq.* (*Baster.*)	.....	.....	.....	*
148. —— scalariformis, *Nyst*	.....	.....	.....	*
149. —— Deshayesii, *De Kon.*	*	*	*	
150. —— erraticus, *De Kon.*	*			
151. —— Koninckii, *Nyst*	*			
152. —— Waelii, *Nyst*	*			
F. regularis, De Kon.				
153. —— Staquiezii, *Nyst*	*			
F. scalaroides, De Kon.				
154. Pyrula decussata, *Bosq.*	.....	.....	.....	*
P. nexilis, Nyst, non Desh.				
155. —— elegans, *Lamk.*	.....	.....	*	
156. Pleurotoma turbida, *Nyst* (*Brander*)	.....	*	.....	*
157. —— crenata, *Nyst*	*	*	*	
P. subdenticulata, Goldf.				
158. —— Waterkeynii, *Nyst*	*	.....	*	*
159. —— belgica, *Goldf.*	.....	.....	*	
160. —— Bosquetii, *Nyst*	*	.....	*	*
161. —— conoidea, *Nyst* (*Brander*)	.....	.....	.....	*
162. —— Selysii, *De Kon.*	*	.....	.....	*
163. —— Dumontii, *Nyst*	.....	.....	.....	*
164. —— semi-colon?, *Nyst* (*Sow.*)	.....	.....	.....	*
165. —— acuticosta, *Nyst*	.....	.....	.....	*
166. —— costellaria, *Duchast*	.....	.....	*	
167. —— Morrenii, *De Kon.*	*			
168. —— Koninckii, *Nyst*	*			
169. —— flexuosa, *Goldf.*	*	*	*	
P. acuminata, Nyst (non Sow.).				

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
170. Cerithium elegans, *Desh.* ..... *C. margaritaceum*, Nyst, non Brocchi.	.....	.....	*	
171. —— subcostellatum, *Schloth.* ..... *C. plicatum*, Lamk. *C. Galeottii*, Nyst.	.....	.....	*	
172. —— incrassatum, *Merian* ..... *C. tricinctum*, Nyst.	.....	.....	*	
173. —— lima, *Desh.*	.....	.....	*	
174. —— Henckeliusii, *Duchast.*	.....	.....	*	
175. Murex Deshayesii, *Duchast.*	*	*	*	*
176. —— fusiformis, *Nyst*	.....	.....	.....	*
177. —— brevicauda, *Hébert* ..... *M. tricarinatus*, Nyst.	.....	.....	.....	*
178. —— Pauwelsii, *De Kon.*	*			
179. Typhis tubifer, *Montf.*	.....	.....	.....	*
180. —— cuniculosus, *Nyst* ..... *T. muticus*, Sow.?	*	*	*	*
181. Triton argutum, *Brander* ..... *T. flandricum*, De Kon.	*	*	*	*
182. Rostellaria ampla, *Brander* ..... *R. macroptera*, Lamk.	.....	.....	.....	*
183. —— fissurella, *Lamk.*	.....	.....	.....	*
184. —— Sowerbyi, *Mant.* ..... *Chenopus Sowerbyi*, Philippi. —— *Margerini*, De Kon.	*	*	*	
185. Cassidaria (Morio) depressa, *V. Buch*	*	*	*	*
186. —— ambigua, *Nyst*	.....	.....	.....	*
187. —— calanthica, *V. Buch*	*			
188. Buccinum Gossardii, *Nyst*	.....	*	*	*
189. —— desertum?, *Brander*	.....	.....	*	
190. —— suturosum, *Nyst*	.....	.....	*	
191. Conus Brocchii?, *Bronn*	.....	.....	.....	*
192. —— lineatus?, *Brander*	.....	.....	.....	*
193. Voluta suturalis, *Nyst*	.....	.....	*	*
194. —— cingulata, *Nyst*	.....	.....	.....	*
195. —— Rathieri, *Hébert* ..... *V. depressa*, Nyst, non Lamk.	.....	*	*	
196. —— semigranosa, *Nyst*	.....	.. ...	.....	*
197. —— semiplicata, *Nyst*	*	*		
198. Terebellum fusiforme?, *Lamk.*	.....	.....	.....	*
199. Ancillaria canalifera, *Lamk.*	.....	.....	.....	*
200. —— buccinoides, *Lamk.*	.....	.....	... ..	*
201. Nautilus ziczac, *Sow.* ..... *Aturia ziczac*, Bronn.	*			
	43	21	106	106

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
131. Sigaretus canaliculatus, *Sow.*	.....	.....	.....	*
132. Bulla Sowerbyi, *Nyst*	.....	.....	.....	*
133. —— utricula, *Brocchi*	.....	.....	.....	*
134. —— acuminata, *Brug.*	.....	.....	.....	*
135. —— constricta?, *Sow.*	.....	.....	*	
136. Limneus fabulum?, *Al. Brong.*	.....	.....	*	
137. Planorbis rotundatus?, *Brong.*	.....	.....	*	
P. corneus?, Drap.				
138. —— depressus, *Nyst*	.....	.....	*	
139. Cancellaria elongata, *Nyst*	.....	.....	.....	*
140. —— quadrata, *Sow.*	.....	.....	.....	*
141. —— evulsa, *Sow.* (*Brander*)	*	.....	*	*
142. —— granulata, *Nyst*	.....	.....	*	
143. Turbinella pyruliformis, *Nyst*	.....	.....	.....	*
144. Cordieria Delucii, *Bosq.* (*Nyst*)	.....	.....	.....	*
145. Fusus elongatus, *Nyst*	*	*	*	*
146. —— multisulcatus, *Nyst*	*	.....	*	*
F. trilineatus, Sow.				
147. —— Burdigalensis, *Bosq.* (*Baster.*)	.....	.....	.....	*
148. —— scalariformis, *Nyst*	.....	.....	.....	*
149. —— Deshayesii, *De Kon.*	*	*	*	
150. —— erraticus, *De Kon.*	*			
151. —— Koninckii, *Nyst*	*			
152. —— Waelii, *Nyst*	*			
F. regularis, De Kon.				
153. —— Staquiezii, *Nyst*	*			
F. scalaroides, De Kon.				
154. Pyrula decussata, *Bosq.*	.....	.....	.....	*
P. nexilis, Nyst, non Desh.				
155. —— elegans, *Lamk.*	.....	.....	*	
156. Pleurotoma turbida, *Nyst* (*Brander*)	.....	*	.....	*
157. —— crenata, *Nyst*	*	*	*	
P. subdenticulata, Goldf.				
158. —— Waterkeynii, *Nyst*	*	.....	*	*
159. —— belgica, *Goldf.*	.....	.....	*	
160. —— Bosquetii, *Nyst*	*	.....	*	*
161. —— conoidea, *Nyst* (*Brander*)	.....	.....	.....	*
162. —— Selysii, *De Kon.*	*	.....	.....	*
163. —— Dumontii, *Nyst*	.....	.....	.....	*
164. —— semi-colon?, *Nyst* (*Sow.*)	.....	.....	.....	*
165. —— acuticosta, *Nyst*	.....	.....	.....	*
166. —— costellaria, *Duchast*	.....	.....	*	
167. —— Morrenii, *De Kon.*	*			
168. —— Koninckii, *Nyst*	*			
169. —— flexuosa, *Goldf.*	*	*	*	
P. acuminata, Nyst (non Sow.).				

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
170. Cerithium elegans, *Desh.* ..... *C. margaritaceum*, Nyst, non Brocchi.	.....	.....	*	
171. —— subcostellatum, *Schloth.* ..... *C. plicatum*, Lamk. *C. Galeottii*, Nyst.	.....	.....	*	
172. —— incrassatum, *Merian* ..... *C. tricinctum*, Nyst.	.....	.....	*	
173. —— lima, *Desh.*	.....	.....	*	
174. —— Henckeliusii, *Duchast.*	.....	.....	*	
175. Murex Deshayesii, *Duchast.*	*	*	*	*
176. —— fusiformis, *Nyst*	.....	.....	.....	*
177. —— brevicauda, *Hébert* ..... *M. tricarinatus*, Nyst.	.....	.....	.....	*
178. —— Pauwelsii, *De Kon.*	*			
179. Typhis tubifer, *Montf.*	.....	.....	.....	*
180. —— cuniculosus, *Nyst* ..... *T. muticus*, Sow.?	*	*	*	*
181. Triton argutum, *Brander* ..... *T. flandricum*, De Kon.	*	*	*	*
182. Rostellaria ampla, *Brander* ..... *R. macroptera*, Lamk.	.....	.....	.....	*
183. —— fissurella, *Lamk.*	.....	.....	.....	*
184. —— Sowerbyi, *Mant.* ..... *Chenopus Sowerbyi*, Philippi. —— *Margerini*, De Kon.	*	*	*	
185. Cassidaria (Morio) depressa, *V. Buch*	*	*	*	*
186. —— ambigua, *Nyst*	.....	.....	.....	*
187. —— calanthica, *V. Buch*	*			
188. Buccinum Gossardii, *Nyst*	.....	*	*	*
189. —— desertum?, *Brander*	.....	.....	*	
190. —— suturosum, *Nyst*	.....	.....	*	
191. Conus Brocchii?, *Bronn*	.....	.....	.....	*
192. —— lineatus?, *Brander*	.....	.....	.....	*
193. Voluta suturalis, *Nyst*	.....	.....	*	*
194. —— cingulata, *Nyst*	.....	.....	.....	*
195. —— Rathieri, *Hébert* ..... *V. depressa*, Nyst, non Lamk.	.....	*	*	
196. —— semigranosa, *Nyst*	.....	.. ...	.....	*
197. —— semiplicata, *Nyst*	*	*		
198. Terebellum fusiforme?, *Lamk.*	.....	.....	.....	*
199. Ancillaria canalifera, *Lamk.*	.....	.....	.....	*
200. —— buccinoides, *Lamk.*	.....	.....	... ..	*
201. Nautilus ziczac, *Sow.* ..... *Aturia ziczac*, Bronn.	*			
	43	21	106	106

TABLE IX. (continued).

	Limburg Series.			
	Upper.			
	Rupelmonde clay.	Bergh, Nucula loam.	Middle.	Lower.
131. Sigaretus canaliculatus, *Sow.*	.....	.....	.....	*
132. Bulla Sowerbyi, *Nyst*	.....	.....	.....	*
133. —— utricula, *Brocchi*	.....	.....	.....	*
134. —— acuminata, *Brug.*	.....	.....	.....	*
135. —— constricta?, *Sow.*	.....	.....	*	
136. Limneus fabulum?, *Al. Brong.*	.....	.....	*	
137. Planorbis rotundatus?, *Brong.* *P. corneus*?, Drap.	.....	.....	*	
138. —— depressus, *Nyst*	.....	.....	*	
139. Cancellaria elongata, *Nyst*	.....	.....	.....	*
140. —— quadrata, *Sow.*	.....	.....	.....	*
141. —— evulsa, *Sow.* (*Brander*)	*	.....	*	*
142. —— granulata, *Nyst*	.....	.....	*	
143. Turbinella pyruliformis, *Nyst*	.....	.....	.....	*
144. Cordieria Delucii, *Bosq.* (*Nyst*)	.....	.....	.....	*
145. Fusus elongatus, *Nyst*	*	*	*	*
146. —— multisulcatus, *Nyst* *F. trilineatus*, Sow.	*	.....	*	*
147. —— Burdigalensis, *Bosq.* (*Baster.*)	.....	.....	.....	*
148. —— scalariformis, *Nyst*	.....	.....	.....	*
149. —— Deshayesii, *De Kon.*	*	*	*	
150. —— erraticus, *De Kon.*	*			
151. —— Koninckii, *Nyst*	*			
152. —— Waelii, *Nyst* *F. regularis*, De Kon.	*			
153. —— Staquiezii, *Nyst* *F. scalaroides*, De Kon.	*			
154. Pyrula decussata, *Bosq* *P. nexilis*, Nyst, non Desh.	.....	.....	.....	*
155. —— elegans, *Lamk.*	.....	.....	*	
156. Pleurotoma turbida, *Nyst* (*Brander*)	.....	*	.....	*
157. —— crenata, *Nyst* *P. subdenticulata*, Goldf.	*	*	*	
158. —— Waterkeynii, *Nyst*	*	.....	*	*
159. —— belgica, *Goldf.*	.....	.....	*	
160. —— Bosquetii, *Nyst*	*	.....	*	*
161. —— conoidea, *Nyst* (*Brander*)	.....	.....	.....	*
162. —— Selysii, *De Kon.*	*	.....	.....	*
163. —— Dumontii, *Nyst*	.....	.....	.....	*
164. —— semi-colon?, *Nyst* (*Sow.*)	.....	.....	.....	*
165. —— acuticosta, *Nyst*	.....	.....	.....	*
166. —— costellaria, *Duchast*	.....	.....	*	
167. —— Morrenii, *De Kon.*	*			
168. —— Koninckii, *Nyst*	*			
169. —— flexuosa, *Goldf.* *P. acuminata*, Nyst (non Sow.).	*	*	*	

TABLE IX. (continued).

	Limburg Series.			
	Upper.		Middle.	Lower.
	Rupelmonde clay.	Bergh, Nucula loam.		
170. Cerithium elegans, *Desh.* ..... *C. margaritaceum*, Nyst, non Brocchi.	.....	.....	*	
171. —— subcostellatum, *Schloth.* ..... *C. plicatum*, Lamk. *C. Galeottii*, Nyst.	.....	.....	*	
172. —— incrassatum, *Merian* ..... *C. tricinctum*, Nyst.	.....	.....	*	
173. —— lima, *Desh.*	.....	.....	*	
174. —— Henckeliusii, *Duchast.*	.....	.....	*	
175. Murex Deshayesii, *Duchast*.....	*	*	*	*
176. —— fusiformis, *Nyst*	.....	.....	.....	*
177. —— brevicauda, *Hébert* ..... *M. tricarinatus*, Nyst.	.....	.....	.....	*
178. —— Pauwelsii, *De Kon.*	*			
179. Typhis tubifer, *Montf.*	.....	.....	.....	*
180. —— cuniculosus, *Nyst* ..... *T. muticus*, Sow.?	*	*	*	*
181. Triton argutum, *Brander* ..... *T. flandricum*, De Kon.	*	*	*	*
182. Rostellaria ampla, *Brander* ..... *R. macroptera*, Lamk.	.....	.....	.....	*
183. —— fissurella, *Lamk.*	.....	.....	.....	*
184. —— Sowerbyi, *Mant.* ..... *Chenopus Sowerbyi*, Philippi. —— *Margerini*, De Kon.	*	*	*	
185. Cassidaria (Morio) depressa, *V. Buch*	*	*	*	*
186. —— ambigua, *Nyst*	.....	.....	.....	*
187. —— calanthica, *V. Buch*	*			
188. Buccinum Gossardii, *Nyst*	.....	*	*	*
189. —— desertum?, *Brander*.....	.....	.....	*	
190. —— suturosum, *Nyst*	.....	.....	*	
191. Conus Brocchii?, *Bronn*	.....	.....	.....	*
192. —— lineatus?, *Brander*	.....	.....	.....	*
193. Voluta suturalis, *Nyst*	.....	.....	*	*
194. —— cingulata, *Nyst*	.....	.....	.....	*
195. —— Rathieri, *Hébert* ..... *V. depressa*, Nyst, non Lamk.	.....	*	*	
196. —— semigranosa, *Nyst*	.....	.. ...	.....	*
197. —— semiplicata, *Nyst*	*	*		
198. Terebellum fusiforme?, *Lamk.*	.....	.....	.....	*
199. Ancillaria canalifera, *Lamk.*	.....	.....	.....	*
200. —— buccinoides, *Lamk.*	.....	.....	... ..	*
201. Nautilus ziczac, *Sow.* ..... *Aturia ziczac*, Bronn.	*			
	43	21	106	106

TABLE IX. (continued).

	Limburg Series.			
	Upper.		Middle.	Lower.
	Rupelmonde clay.	Bergh, Nucula loam.		
ANNELIDES.				
Serpula turbinata?, *Philippi*	.....	.....	.....	*
Galeolaria trochoides, *Nyst*	.....	.....	.....	*
Cyclolites, Nyst.				2
CIRRIPEDA.				
Balanus, sp. non determ.	.....	.....	*	
			1	
ENTOMOSTRACA.				
Cytherella compressa, *Bosq.* (*Münster*)	*	*		
Bairdia punctatella, *Bosq.*	.....	*		
—— marginata, *Bosq.*	.....	*		
—— lithodomoides, *Bosq.*	.....	*		
Cytheridea Mulleri, *Bosq.* (*Münster*)	.....	*	*	
—— papillosa, *Bosq.*	.....	*		
—— Williamsoniana, *Bosq.*	.....	.....	*	
Cythere scrobiculata, *Münster*	.....	*	.....	
—— striato-punctata, *Bosq.* (*Roemer*)	.....	.....	.....	*
—— Jurinei, *Münster*	.....	.....	*	*
—— plicata, *Münster*	.....	*		
—— Nystiana, *Bosq.*	.....	*		
—— Reussiana, *Bosq.*	.....	*		
—— ceratoptera, *Bosq.*	*	*		
—— Lyelliana, *Bosq.*	*			
	3	11	3	2
PISCES.				
Myliobates (Ætobates?), sp. non determ.	.....	.....	*	
Notidanus primigenius, *Agass.*	*	.....	*	
Galeocerdo minor, *Agass.*	*	.....	*	
Lamna contortidens, *Agass.*	.....	.....	*	
—— cuspidata?, *Agass.*	*	.....	*	
—— compressa?, *Agass.*	*			
—— elegans, *Agass.*	*			
Otodus obliquus, *Agass.*	*			
Oxyrhina xiphodon, *Agass.*	*			
—— trigonodon, *Agass.*	*			
—— Desorii?, *Agass.*	*			
Carcharodon angustidens, *Agass.*	*			
—— heterodon, *Agass.*	*			
	11		5	

Table X.

Showing the Relative Numbers of Species in the different Divisions of the Limburg Tertiary Strata, and the Species common to the several Divisions.

	Upper Limburg.		Middle Limburg.	Lower Limburg.
	A., or Rupelmonde clay.	B., or Nucula-loam of Bergh.		
Total number of species of Mollusca	43	21	106	106
Species peculiar	20	1	65	68

Species common to	A. and B.	A. and Middle.	B. and Middle.	A. and Lower.	B. and Lower.	Upper and Middle.	Upper and Lower.	Middle and Lower.
	12	19	16	17	12	25	22	33

Table XI.

Fossils common to the Limburg Beds and to English Eocene Strata.

(U. M. and L. indicate Upper, Middle, and Lower Limburg.)

	Limburg Divisions.	British and other Localities.
1. Clavagella tibialis?	L.	Calcaire grossier.
Leguminaria papyracea	L.	Calcaire grossier.
Solecurtus compressus	M. L.	Upper Marine, Barton, Bracklesham.
Mya angustata?	M.	Upper Marine, Isle of Wight.
5. Lutraria oblata?	U.	Pegwell Bay; Herne Bay; Bognor.
Corbula pisum	U. M. L.	Barton; Bracklesham.
—— striata	M. L.	Barton.
Psammobia rudis	M.	Barton; Calc. gross.
Lucina Thierensii	M.	Upper Marine, Hants.
10. Diplodonta apicalis	L.	Barton (species very near, if not identical—*Morris*).
Axinus Nystii	U. M. L.	Lond. Clay proper, Highgate.
Cyrena semistriata	M.	Upper Marine, Isle of Wight.
Venus lævigata	M. L.	Barton; Calc. gross.
—— sulcataria	U. L.	Bracklesham (Messrs. Morris and Edwards find no difference in the species).
15. —— incrassata and varieties	U. M. L.	Upper Marine, Hants.

TABLE XI. (continued).

		Limburg Divisions.	British and other Localities.
	Venus Kickxii	M.	Barton?
	Cardium hippopæum	L.	Bracklesham; Calc. gross.
	—— porulosum	L.	Bracklesham.
	Cypricardia pectinifera	L.	Barton.
20.	Cardita Kickxii?	U.	Barton.
	Nucula similis	L.	Barton; Highgate.
	Limopsis scalaris	L.	Barton.
	Pectunculus fossilis	M.	Bracklesham.
	Mytilus Faujasii	M.	Upper Marine.
25.	—— corrugatus?	M.	Vicentine, Eocene.
	Dreissena Basteroti	M.	Upper Marine.
	Pinna affinis?	L.	Bognor; Highgate.
	Pecten reconditus	L.	Barton.
	—— corneus	L.	Bracklesham.
30.	Ostrea cariosa	L.	Calc. gross.
	—— gigantea	M.	Barton.
	—— bellovacina?	M.	Woolwich; Lower tertiaries.
	Capulus cornucopiæ	M. L.	Bracklesham; Calc. gross.
	Infundibulum lævigatum	M.	Calc. gross.
35.	Phorus extensus	L.	Barton; Calc. gross.
	Ampullaria mutabilis	M. L.	Barton and Upper Marine.
	Paludestrina Draparnaudii	M.	Upper Marine, Hants.
	—— pupa	M.	Upper Marine.
	Rissoina Nystii	M.	Upper Marine, Hants.
40.	Rissoa? Chastelii	M.	Upper Marine, Hants.
	Actæon simulatus	U. M. L.	Barton; Highgate.
	Turbonilla spina	M.	Calc. gross.
	Niso terebellata	L.	Bracklesham.
	Nerita concava	M.	Up. Mar., Hants; Calc. gross.
45.	Natica glaucinoides	U. M.	Barton; Bracklesham.
	—— hantoniensis	M. L.	Barton; Bracklesham.
	Sigaretus canaliculatus	L.	Barton.
	Bulla acuminata	L.	Barton.
	—— constricta	M.	Barton; Calc. gross.
50.	Limneus fabulum	M.	Freshwater, Isle of Wight.
	Planorbis rotundatus	M.	Freshwater, Isle of Wight.
	Cancellaria evulsa	U. M. L.	Barton; Calc. gross.
	—— quadrata	M.	Barton.
	Fusus multisulcatus	U. M. L.	Highgate?; Calc. gross.?
55.	—— scalariformis	L.	Barton.
	Pyrula elegans	M.	Calc. gross.
	Pleurotoma turbida	U. L.	Barton.
	—— flexuosa	U. M.	Barton.
	—— crenata	U. M.	Barton.
60.	—— Selysii	U. L.	Highgate.
	—— semicolon?	L.	Barton; Highgate.
	—— conoidea	L.	Barton.
	Cerithium elegans	M.	Barton.
	—— lima	M.	Upper Marine.
65.	—— plicatum	M.	Upper Marine.
	—— incrassatum	M.	Upper Marine, Hants.

TABLE XI. (continued).

		Limburg Divisions.	British and other Localities.
	Typhis cuniculosus	U. M. L.	Barton?
	Triton argutum	U. M. L.	Barton, Highgate.
	Rostellaria ampla	L.	Barton.
70.	—— fissurella	L.	Barton; Calc. gross.
	—— Sowerbyi	U. M.	Highgate.
	Cassidaria ambigua	L.	Barton.
	Buccinum Gossardii	U. M. L.	Barton.
	—— desertum	M.	Barton.
75.	—— suturosum	M.	Barton.
	Conus lineatus?	L.	Barton.
	Terebellum fusiforme?	L.	Barton; Bracklesham.
	Ancillaria canalifera	L.	Barton.
	—— buccinoides	L.	Barton; Calc. gross.
80.	Nautilus ziczac	U.	Highgate; Sheppey.

7. *Nomenclature of the Limburg Tertiary Strata; and whether they should be referred to the Upper Eocene or Lower Miocene periods.*

My original reasons for not classifying the upper marine strata of the Paris basin, commonly called "sables de Fontainebleau," &c., and the upper marine and freshwater of the Isle of Wight as Miocene, were threefold.

1st. Because many of the shells were identical with fossils from the Calcaire grossier, Barton clay, and other Eocene beds, while the general aspect of the fauna resembled that of the lower, rather than of the upper tertiary strata.

2ndly. Because of the great distinctness of the fauna from that of the faluns of Touraine, which contained above 300 species of shells, and which I had chosen as the type of the Miocene period.

3rdly. Because the proportion of recent species did not appear to be sensibly greater than in the Eocene strata, regarded as a whole.

Geologists will be enabled by means of the Tables given above to appreciate the true merits of this question. It will be seen that out of 201 species of Limburg mollusca, eighty are identical with fossils commonly regarded by English geologists as Eocene. Even if we omit seventeen species which occur, fifteen of them in the upper marine of Hampshire, and two in the associated freshwater beds, still we have sixty-three Eocene species in a list of 201. Ten of these identifications, however, are given doubtfully, because the means of comparison were more or less deficient. If we exclude all these, we have still fifty-three remaining. I am, however, by no means disposed to exclude the Upper Marine of Hampshire from the Eocene period, as the number of species common to it and to the Barton beds is shown by old and modern researches, especially by Dr. Wright*, to be considerable.

* Proceedings of the Cotswold Naturalists' Club for 1850, p. 87 *et seq.*; and Ann. and Mag. N. Hist. 2 ser. vol. vii. p. 14 *et seq.*

If we next turn to the fifty-two Upper Limburg species (Table X.), it will be seen that nineteen are identified with English Eocene fossils, one only of the number (*Venus incrassata*) being admitted on the disputed ground of its occurring in beds so modern as the Upper Marine of Hampshire. In regard to two of the species also, we require fuller information before we can feel sure of their agreement.

Out of 106 Middle Limburg species, forty-eight are British Eocene, but thirteen of these must be deducted by those who do not consider the upper marine and the freshwater beds of Hampshire as Eocene. Even after this deduction, together with two others as doubtful, nearly a third of the whole are common to undoubted Eocene beds.

Lastly, out of 106 Lower Limburg fossils, forty-four are British (or well-known French) Eocene shells, and only one of these (*Venus incrassata*) would have to be excluded as occurring only in the Upper Marine of Hants. If we omit five others as doubtful, for want of ample means of comparison, there remain thirty-eight Eocene species, or more than a third. This is as great a resemblance as can usually be affirmed of any one of the great members of the English or French Eocene divisions, when compared with another,—the Barton beds, for example, with the Highgate, or the Calcaire grossier with the Sables inférieurs Soissonnais.

It is natural to find a larger proportion of shells in the Lower Limburg, than in the Upper, common to the older Eocene. Among the nineteen shells of the latter identified with Eocene species, eleven occur in the Barton clay, or high up in the English series. When in the 'Principles of Geology' I placed the Mayence basin in the Miocene division, my classification was in that respect inconsistent with itself, for M. de Koninck pointed out to me in 1850 his reasons for concluding, many years before, that a great many of the Mayence fossils agreed with the Limburg and Rupelmonde strata*. M. Bosquet has since observed to me, that it is with the Middle, and not with the Lower Limburg division, that this analogy with the Mayence basins holds good.

In the paper by M. Hébert before referred to†, it will be seen that he enumerates twenty-four species of shells from the "Ostrea cyathula clay" and "Sables de Fontainebleau," &c., at Paris, Etampes, and other places in France, as decidedly identical with Limburg and Rupelmonde fossils. All of these are found in the Middle or Upper Limburg beds, and only nine in the Lower Limburg. This greater agreement with the former arises partly from the presence of freshwater species, none of which occur in the Lower Limburg. Of the twenty-four French species, four are common to the Rupelmonde Clay (or 4 in 43), and nine to the Lower Limburg beds (or 9 in 106); so that the relationship of the French fossils, taken as a whole, with the highest and lowest divisions of the Belgian formations, which are both of them marine, do not seem to differ essentially.

I have met with no Nummulites in any of the Belgian Upper

* See 'Manual of Geology,' 1851, p. 177; where I alluded to the agreement of the Belgian and Mayence beds with those of Hermsdorf near Berlin.

† Bulletin de la Soc. Géol. de France, t. vi. p. 459. 1849.

Eocene strata, whether at Rupelmonde or Kleyn Spawen. In that country, as in England and France, they seem to characterize the Middle Eocene series, and not to occur in the Upper or Lower Eocene; a result corresponding to that at which M. d'Archiac had previously arrived in France.

The proportion of recent species in the 201 fossil Mollusca of the Limburg beds has still to be considered. I may safely affirm that it is not greater than in older or universally acknowledged Eocene formations. The following fossils have been supposed to agree with living shells:—

1. Cyprina islandica?, var.
2. Rissoina Nystii.
3. Rissoa violacea? *R. plicata.*
4. Planorbis corneus? *P. rotundatus?*
5. Limneus fabulum?
6. Solen ensis, var.?
7. Ostrea cochlear.

Judging from one valve of the *Cyprina* above mentioned, given to me by M. Bosquet, Professor Forbes believes the shell to differ from the living species; the muscular impression being larger, and the pallial impression not similar. *Rissoa plicata*, Desh., appeared to M. Bosquet to agree perfectly with *R. violacea*, Frem. and Desm., a Mediterranean shell, but Prof. E. Forbes, after carefully comparing them, is not satisfied with the identification; and he remarks, in regard to the genera *Rissoina* and *Rissoa*, that there is so great a want of unanimity among the best naturalists as to the value of the specific characters of some of the commonest living species, such as *Rissoa balthica*, that it would be dangerous to attempt to identify fossils in these genera with living molluscs, when they occur as members of a fauna decidedly extinct. The same remark will apply to *Limneus*, *Planorbis*, and *Ostrea*. I do not possess the means of comparing the *Solen* alluded to by M. Nyst. Two or three of the Entomostraca, as *Bairdia lithodomoides* and *Cytheridea Mulleri*, are pronounced, on the high authority of M. Bosquet, to be quite undistinguishable from living species. Such identifications do not affect the data on which my original nomenclature of tertiary classification was founded, as I confined myself exclusively to the fossil mollusca.

With regard to the faluns of Touraine, although containing more than 300 species of shells, there are scarcely any species identical with those of the Limburg; so that the greater analogy of these last with the Eocene type, than with that which I have always considered as Miocene, is striking.

§ 7. *On the Middle Eocene Strata of Belgium and French Flanders, or the "Nummulitic Eocene"* (E. 1, 2, 3, Table I. p. 279). *Systèmes Laekenien, Bruxellien et Ypresien, étage supérieur*, of M. Dumont.

The group of tertiary strata which we meet with next in the descending order in Belgium (comprising the "Systèmes Laekenien, Bruxellien et Ypresien" of M. Dumont) corresponds most nearly, if

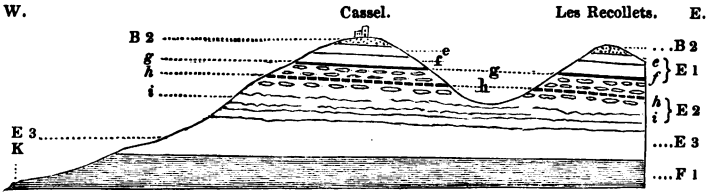
not entirely, in age with the Barton, Bagshot, and Bracklesham beds of the London and Hampshire basins, and with the *Sables moyens*, *Calcaire grossier*, and part of the *Sables inférieurs* of the Parisian series. The two districts where I studied them principally were the neighbourhood of Brussels and that of Cassel, in French Flanders.

1. *Eocene Tertiary Strata of Cassel, near Dunkirk. Hill of Cassel, Mont Noir, and Hill of Boeschepe.*

I shall first describe the Cassel district, because some of the Eocene strata there occupy a somewhat higher position than any fossiliferous strata older than the Limburg series known at present in other parts of French Flanders and Belgium.

The town of Cassel, situated about twenty miles S.S.E. of Dunkirk (see Map, Pl. XVII.), stands on the summit of a hill, 515 English feet (157 metres) above the level of the sea. This hill rises on its north, south, and west sides very abruptly from the surrounding plain, which is about 400 feet below the level of the top of the hill. The railway-station (K. fig. 4), at the western base of the hill, has been ascertained to be 40 metres (131 English feet) above the sea. The Hill of Cassel is the most western of a small chain which extends ten or twelve miles in a south-easterly direction into Belgium, the town of Ypres being situated near its eastern extremity. These hills are all of very similar composition, geologically speaking, although the Hill of Cassel displays, upon the whole, the greatest number of well-characterized subdivisions of the tertiary series. It will be useful therefore to consider it as a type, and to compare the others with it.

Fig. 4.—*Section of the Hill of Cassel.*



B 2. Diest sands.
E 1. (Laeken beds). *e*. Ferruginous sands (upper part of E 1 ?). *f*. Sandy glauconite (middle part of E 1 ?). *g*. "Black band," with *Num. variolarius*.
E 2. (Brussels beds). *h*. *Num. lævigatus* bed. *i*. Green marls and underlying sands, with *Num. lævigatus*.
E 3. Sands, clays, &c. Lower Nummulitic?
F 1. London Clay with septaria. Bored to a depth of 320 feet.
K. Cassel railway-station.

This hill, like all the others, is capped with ferruginous sands and sandstone, doubtlessly belonging to the Diest sands (B. 2. Table I. p. 279 and fig. 4), as usual barren of fossils. Their thickness at Cassel cannot be measured, but on the summit of the hill of Mont Noir, near Bailleul, about fourteen miles to the south-east (see Map, Pl. XVII. fig. 1), this formation is seen to be 20 feet thick. In that hill, which is 430 feet above the level of the sea, the Diest sands consist, at their base, of a conglomerate of flint-pebbles coated with hydrate of

iron. In the sands above this conglomerate are many geodes and large hollow pipe-like concretions of hydrate of iron. Below are ochreous, yellow, ferruginous sands (*e*), which M. Meugy, adopting the opinion of M. Dumont, has called "Tongrian" in his map of French Flanders, thereby implying that they belong to the Limburg or Upper Eocene series described above, § 6. They are about 50 feet thick in Mont Noir (where they are far better exposed to view than at *e*, fig. 4, in the Hill of Cassel), and at the depth of 30 feet from the top contain an irregular and discontinuous bed of rolled chalk-flints, some of them large, or from 4 to 8 inches in diameter. Ferruginous sands are seen above and below the gravel. In some of those immediately below it are casts of shells, to which my attention was first called by M. Meugy, and of which many were collected for me by M. Curtel, a French engineer, with whom I explored the hill.

Fossil Shells of the Ferruginous Sands next below the Diest Sands in Mont Noir near Cassel.

1. Corbula gallica, *Lamk.*
2. ——, another species.
3. Thracia?
4. Sanguinolaria Hollowaysii, *Sow.*
5. Tellina.
6. Lucina divaricata?, *Lamk.*
7. Cytherea suberycinoides, *Desh.*
8. ——, another species.
9. Cardium porulosum, *Brander.*
10. —— semigranulatum, *Sow.*
11. —— turgidum, *Brander.*
12. Pecten reconditus, *Brander*, sp.
13. Ostrea inflata, *Desh.*
14. Dentalium strangulatum, *Desh.*
15. *Ditrupa?*
16. Natica sigaretina, *Lamk.*
17. —— patula, *Desh.*
18. —— ambulacrum, *Sow.* sp.
19. Turritella imbricataria, *Lamk.*
20. Buccinum junceum, *Sow.*
21. Voluta.
22. Conus antediluvianus?, *Lamk.*

The *Sanguinolaria Hollowaysii* is a well-known English species, occurring at Bracklesham, and the whole list is such as we might meet with in the Upper Bagshot Sands, to which these beds bear a considerable mineralogical resemblance. The absence of all fossils peculiar to the Limburg series, both here and in the Cassel chain of hills generally, makes me question the propriety of referring these sands to the "Tongrian" beds of Dumont. The casts of *Ostrea inflata* are numerous, and this fossil abounds at Cassel, as we shall presently see, in beds (lower in the series) which contain *Nummulites variolarius* in profusion. At Mont Noir the section below the ferruginous sands is imperfectly seen or barren of fossils, but in the neighbouring hill of Boeschepe, to the westward, the same yellow irony sands as those of Mont Noir recur, with some white and green sands associated, beneath which are grey, bluish, and greenish sands, 20 feet thick, with thin layers of clay, and a fossiliferous glauconite, which I shall now describe.

The glauconite alluded to is only 6 inches thick. It contains coarse grains of blackish green earth, and is without calcareous matter. It was laid open in a cutting, at the time of my visit, for a road which runs south and north from the village of Berthen to Boeschepe (see Map, Pl. XVII. fig. 1). Casts of the following fossil shells occurred in the glauconite, only a few feet below the level of the watershed of the ridge, and on its northern side.

Shells of the Glauconite of the Hill of Boeschepe near Cassel.

1. Crassatella plicata?, *Sow.*
2. Lucina squamula, *Desh.*
3. Cytherea or Venus.
4. Cardium porulosum, *Brander.*
5. ——, with fine striæ.
6. ——, third species.
7. Cardita acuticostata?, *Lamk.*
8. Arca barbatula, *Lamk.*
9. Mytilus acutangulus, *Desh.*
10. Mytilus, another species.
11. Ostrea flabellula?, *Lamk.*
12. Fusus or Murex?; allied to *M. frondosus* or *M. cornutus.*
13. Cassidaria carinata?, *Lamk.*
14. Voluta digitalina?, *Lamk.*
15. Cypræa; cast, allied to *C. inflata,* Lamk.
16. Ovula; of very large size.

Cardium porulosum, an *Ostrea* (probably *O. flabellula*), and a *Mytilus,* are the most common among the casts. The most striking fossil, however, was one discovered here by M. Curtel, and now in the collection of M. Meugy at Lille. It is an *Ovula* of the size of *Cypræa Coombii,* Dixon, 'Foss. Suss.' pl. 8. fig. 6, or of *Ovula tuberculosa,* Desh. 'Coq. Foss. de Paris,' pl. 97. fig. 17. On my showing the cast, however, to M. Deshayes, he pronounced it to be different, and to agree with an unpublished shell, of which he possesses imperfect remains from a bed of the *Calcaire grossier* at Chaumont in France, overlying strata containing *Cerithium giganteum.*

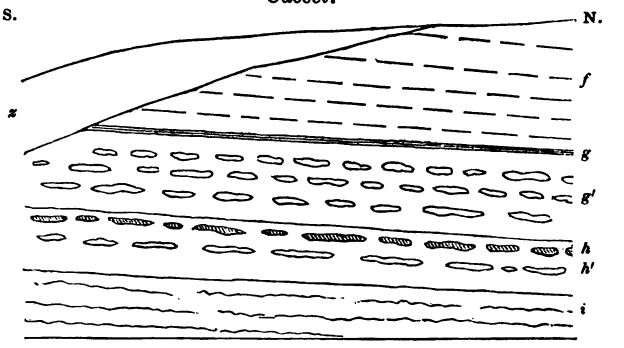
As the Boeschepe glauconite succeeds immediately to the ferruginous sands, and, according to M. Curtel, occurs at the height of 112 metres above the sea (only 12 metres below the summit of the hill of Boeschepe), I am inclined to identify it with a similar glauconite found at Cassel (at *f*, fig. 4) above the "bande noire" (*g*, fig. 4), afterwards to be mentioned; but, as the nummulitic beds of Cassel have not yet been observed in the hills of Boeschepe or Mont Noir, I cannot decide with confidence on its exact position.

We may now return to the Hill of Cassel, which, as before stated, is capped by the Diest sands (B 2, fig. 4), under which are other ferruginous strata (*e*, fig. 4), as yet unproductive of fossils, but which I believe to be of the same age as the Mont Noir beds already described. M. Meugy estimates the united thickness of these sands, B 2, and *f*, fig. 4, at 56 feet. Their junction with the beds next below is not seen, but on the eastern slope of the hill, which faces the Mont des Recollets, a section is laid open in an excavation for stone and sand, called Caton's Pit from the person who now works it, which may be regarded as exhibiting the continuation of the series. The mass of clay without fossils on the left side of this section (*z*, fig. 5) is unconformable, as here represented. It is of considerable thickness, perhaps 20 to 30 feet; but neither could I, nor M. Meugy who examined it with me, determine its true age.

(1.) The bed *f*, figs. 4 & 5, is 34 feet thick, and consists of a sandy glauconite with some thin layers of clay in its lower portion. In parts it is spotted with yellow; in other beds it contains coarse blackish-green grains like those of the glauconite of Boeschepe, and, as in that hill, impressions of shells occur, the calcareous matter of the shell having wholly disappeared. The only recognizable species were *Pecten corneus* and *Cardium semigranulatum.* The general dip of these strata

and of those immediately subjacent is at a slight angle towards the north-east.

Fig. 5.—*Section in Caton's Pit, on the eastern slope of the Hill of Cassel.*



z. Bed of clay, without fossils.
f. Sandy glauconite (1).
g. "Black band" with *Ostrea inflata* and *Num. variolarius* (2).
g'. Sands with *Nipadites, Nautilus, Cerithium giganteum, Num. variolarius*, &c. (3 to 6).
h. Green sand and sand-rock with *Num. lævigatus* (7).
h'. Sands and sandstone with *Ostreæ*, &c. (8 to 10).
i. Green marls (11).

(2.) Next below is a dark bed, called by the workmen *la bande noire* (*g*, figs. 4 and 5), 1½ foot thick. It is divided in some places by thin layers of yellow sand, in which I found the following fossils:

Shells of the "Bande noire," Cassel (*g*, figs. 4 & 5).

Nummulites variolarius, *Lamk.*
Cryptodon?
Venus; small.
Cardita.
Nucula margaritacea, *Lamk.*
Pecten imbricatus? *Desh.*
Pecten plebeius, *Lamk.*
Anomia lævigata, *Sow.*
Ostrea inflata, *Desh.*
Dentalium strangulatum, *Desh.*
Natica.
Turritella.

The presence of *Nummulites variolarius* and *Ostrea inflata* indicates the commencement of those Eocene strata which are called at Brussels the "Laeken beds," and to a higher division of which those sands in the Cassel hills, which have been hitherto called "Tongrian," may perhaps belong.

(3.) Immediately below the *bande noire* are beds of yellowish sand with green grains, 9 feet thick. Within a foot of the top of this mass is an irregular layer of sandstone, or a bed of nodules of sand cemented by calcareous matter, in which many of the following fossils occur in the state of casts, while the rest are free in the sand.

Nummulites variolarius, *Lamk.*; very abundant.
Turbinolia sulcata, *Lamk.*
T. Nystiana? Haime.
Lunulites radiatus, *Lamk.*
Clavagella coronata, *Desh.*
Teredina.
Corbula pisum, *Sow.*
Tellina rostralis, *Lamk.*
Lucina (Loripes) divaricata, *Lamk.*
Venus; the same as one found at Laeken.
Venus elegans? *Sow.*
Cytherea suberycinoides, *Desh.*

Cypricardia pectinifera, *Morris*.
Cardium semigranulatum, *Sow*.
—— obliquum, *Desh*.
Cardita elegans, *Lamk*.
Nucula (Leda) Galeottiana, *Nyst*.
Pecten plebeius, *Lamk*.
Ostrea inflata, *Desh*.
Dentalium strangulatum, *Desh*.
Turritella imbricataria (young)? *Lamk*.
Myliobates.
Nipadites Burtini; drilled by *Teredinæ*.

In a sandstone cast of *Nipadites* (once regarded as a cocoa-nut by Burtin) which retains perfectly its shape, we see the tubes of *Teredinæ* in great numbers, these mollusks having evidently drilled the husk of the floating fruit through and through. The occurrence of two specimens of this fossil in this bed, with *Nummulites variolarius, Tellina rostralis, Cypricardia pectinifera*, and other Laeken shells, shows that the plant is referable here to a higher part of the series than that in which it is found in the environs of Brussels, which, as we shall afterwards see, is below the level of the *Nummulites lævigatus*. In the Sheppey clay the same *Nipadites* is seen to range still lower in the Eocene series.

That these fruits were drifted down to the sea is shown by their being perforated by *Teredinæ*, and I am informed by Dr. Hooker that no fruits are so often met with floating down the arms of the Ganges, in the delta near the sea, as those of *Nipa fruticans*. They are often so abundant that the paddle-wheels of steamboats are obstructed by them.

(4.) Next below is a bed of whitish and yellow sand, 3½ feet thick, containing in its upper part a bed of concretions of sandstone about 10 inches thick. The fossils are—

Nummulites variolarius, *Lamk*.
Lunulites radiatus, *Lamk*.
Tellina sinuata? *Lamk*.
Lucina.
Solarium (Vermetus) Nystii, *Gal*.

(5.) "Nautilus-bed," 3½ feet thick. Grey and yellow sand, with a bed of soft sandstone in nodules in the upper part, 1 foot thick, containing

Lucina (Loripes) divaricata, *Lamk*.
Pecten scabriusculus, *Math*.
—— plebeius, *Lamk*.
Anomia lævigata, *Sow*.
Turritella.
Nautilus Burtini, *Gal*.
Crab's claw.
Vertebræ and teeth of Lamna.

No less than four specimens of *Nautilus*, all perfect, though in a decomposing state, were dug out of the bed when I was present. One variety resembles *N. imperialis* in general form, but seems to be the same species as *N. Burtini*.

(6.) "*Cerithium giganteum* bed;" thickness 1 foot 8 inches. Yellowish sand with grains of green earth, and containing in its upper part an irregular bed of shelly sandstone, one foot thick; both in the loose sand and in the stone rolled pebbles of chalk-flints occasionally occur. The fossils are—

Nummulites variolarius, *Lamk*.
Lunulites radiatus, *Lamk*.
Turbinolia sulcata, *Lamk*.
T. Nystiana? Haime.
Lucina mutabilis, *Lamk*.
—— contorta? *Def*.
—— divaricata, *Lamk*.
Cytherea lævigata, *Lamk*.
Cardita elegans, *Lamk*.
Nucula margaritacea, *Lamk*.
—— striata, *Lamk*.
Pecten scabriusculus, *Math*.
—— plebeius, *Lamk*.
—— corneus, *Sow*.
Ostrea flabellula, *Lamk*.
—— virgata, *Goldf*.

Terebratula Kickxii, *Gal.*
Solarium (Vermetus) Nystii, *Gal.*
Turritella edita, *Sow.*; very abundant.
Cerithium giganteum, *Lamk.*; abundant.
Cassidaria nodosa, *Nyst.*
—— carinata, *Lamk.*
Nautilus Burtini, *Gal.*
Echinolampas Galeottianus, *E. Forbes*; abundant in lower part of bed.
—— affinis ?, *E. Forbes.*
Clypeaster affinis ?, Goldf.
Crab's claw.
Vertebræ and teeth of Lamna.
Myliobates.

In the highest part of the bed, above the nodules of stone, *Cerithium giganteum* occurs in great numbers with *Turritella edita*. *Nummulites variolarius* is seen in the sand filling the interior of the *Cerithia*. *Nummulites lævigatus* occurs, so far as I observed it, below the stony bed, and marks the beginning of the beds where that larger species abounds, although at the contact both might possibly be detected in the same stratum. The *Cerithium giganteum* bed is probably about the level of the line of junction of the "Laeken" and "Brussels" Middle Eocene divisions hereafter to be described in the environs of Brussels.

(7.) "*Nummulites lævigatus* bed" (*h*, figs. 4 & 5); thickness 1½ foot. This bed consists in parts of a hard greenish sand-rock, containing *Nummulites lævigatus* and *N. scaber*, and partly of incoherent sand with green grains, with the same species of *Nummulites* loose and disseminated. The molluscs mentioned in the following list occur both in casts and as shells in the sand. The teeth of Sharks are numerous.

Nummulites lævigatus, *Brug.*; very abundant.
—— scaber, *Lamk.*; very abundant.
Gastrochæna.
Crassatella.
Cytherea lævigata, *Lamk.*
Lucina mutabilis, *Lamk.*
Cardium semigranulatum, *Sow.*
—— porulosum, *Brander.*
Cardita planicostata, *Lamk.*
Pectunculus.
Nucula Galeottiana, *Nyst.*
Ostrea flabellula, *Lamk.*
—— virgata, *Goldf.*
—— cymbula, *Lamk.*
Terebratula Kickxii, *Nyst.*
Natica; two species.
Turritella imbricataria, *Lamk.*
Asterias (Goniaster) poritoides?, *Desm.*; marginal ossicles.
Echinolampas Galeottianus, *E. Forbes.*
Lamna elegans, *Agass.*
Otodus macrotus, *Agass.*
Myliobates.

Prof. E. Forbes, on my explaining to him the relative abundance of the shells in this and most of the incumbent beds at Cassel, is of opinion that they were probably deposited in a depth of about 15 fathoms, or at the lowest part of his "perilittoral zone."

(8.) "Oyster-bed;" thickness 5 feet. Yellowish and greenish-grey sand, with great numbers of *Ostreæ* (*O. flabellula*) dispersed through it.

(9.) Bed of hard sandstone with calcareous cement; thickness 1 foot 6 inches; containing

Nummulites scaber, *Lamk.*
Corbula gallica, *Lamk.*
Thracia.
Mactra semisulcata, *Lamk.*
Tellina.
Cytherea lævigata, *Lamk.*
Lucina (Loripes) divaricata, *Lamk.*
Cardium; like *C. discors*, Lamk.
Cardium porulosum, *Brander.*
Cardita planicostata, *Lamk.*
Pectunculus.
Ostrea flabellula, *Lamk.*
Dentalium strangulatum, *Desh.*
Stomatia.
Melania marginata, *Lamk.*
Fusus bulbiformis, *Lamk.*
Buccinum stromboides, *Herm.*
Rostellaria fissurella, *Lamk.*
—— macroptera, *Lamk.*
Conus deperditus (young)?, *Brug.*
Terebellum.
Asterias.

(10.) "White sands;" with three or four layers of stone similar to those above described, each 8 or 10 inches in thickness, with few casts of shells, one of them a cast of *Lucina divaricata*. Some of the sand snow-white; the lower 8 feet, in which the sand is whitest, not exposed, but pierced by boring.

(11.) "Green marls" (*i*, figs. 4 & 5); thickness 12 feet. Here the continuous section ceases, but I have no doubt that the green marls and glauconite seen at a lower level immediately to the north (in an adjoining deep lane, at the distance of a few hundred yards only), and similar beds occurring to the eastward (in the road leading up the slope of the Mont des Recollets), are next in the descending order. Some of this coarse-grained sandy glauconite is very dark-coloured, and in parts very calcareous. I obtained from it the following fossils:

Turbinolia sulcata, *Lamk.*
Cytherea lævigata, *Lamk.*
—— suberycinoides? *Desh.*
Cardium porulosum, *Brander.*
——, another species.
Cardita decussata, *Lamk.*
Pectunculus.
Ostrea virgata, *Goldf.*
—— flabellula, *Lamk.*
Dentalium.
Bifrontia serrata, *Desh.*
Turritella multisulcata, *Lamk.*, or intermedia? *Desh.*
—— imbricataria, *Lamk.*
Sigaretus canaliculatus, *Sow.*
Natica parisiensis, *D'Orb.*
Pleurotoma.

Between the green fossiliferous marls last mentioned (*i*, figs. 4 and 5) and the upper part of the Mont des Recollets, where there is a large deserted quarry on the western brow of the hill, we may trace in the ascending order nearly all the beds already described, from *i*, figs. 4 and 5, to the *Bande noire*. Several of the stony concretionary sandstones are visible, and, overlying these, the *Bande noire* itself, with *Ostrea inflata* and *Nummulites variolarius*, is very conspicuous. Above the whole appear the glauconiferous and ferruginous beds considered as "Tongrian" by MM. Dumont and Meugy, *e*, fig. 4, and the Diest sand, B 2.

There is a large sand-pit at the south-eastern base of the Hill of Cassel, belonging to M. Planque, at a somewhat lower level than the green marls (*i*) already described, where a vertical section of sands 50 feet thick is laid open. Here several oblique shifts occur, intersecting the beds at a high angle, one of which has thrown down some of the strata as much as 12 feet perpendicularly. At the top of the pit are greenish and yellow sands without fossils. Lower down there are from 35 to 40 feet of white and yellow sands; and in some seams of the yellow sands stained with ferruginous matter, I found numerous specimens of *Nummulites lævigatus* and *N. scaber* in a very decomposed state, so that M. d'Archiac had much difficulty in identifying the species. Lastly, at the bottom of the whole is a white sand, 5 feet thick, passing occasionally into a sandstone with casts of shells, below which dark green sands and glauconite have been pierced in boring. The absence of the five or six stony beds, *g'* and *h'*, fig. 5, in these white sands of M. Planque's quarry makes it difficult to imagine that we have here the representatives of the same series as in Caton's pit; the difference of level would not of itself be a valid ar-

gument to prove their greater antiquity, because a fault may have thrown them down. I am rather of opinion that the beds of the quarry are older than the green marls or shelly glauconite, *i*, figs. 4 and 5.

The following are the fossils found by me in the sandstone :—

Fossils of the Sand-pit at the south-east base of the Hill of Cassel, or Planque's quarry.

Lunulites.
Solen.
Panopæa intermedia ?, *Sow.*
Corbula.
Mactra semisulcata ? *Lamk.*
Lucina divaricata, *Lamk.*
—— mutabilis, *Lamk.*
Cytherea lævigata, *Lamk.*
——; allied to *C. nitidula*, Lamk.
Cardium porulosum, *Brander.*
——; like *C. discors*, Lamk.
Cardita planicostata, *Lamk.*
Nucula margaritacea, *Lamk.*
Pectunculus ; large species.
Limopsis ?
Ostrea flabellula, *Lamk.*
Ostrea cymbula, *Lamk.*
Vermetus Bognorensis?, *Sow.*, or Nystii?
Trochus agglutinans, *Lamk.*
Phorus Parisiensis, D'Orb.
Turritella.
Natica patula, *Desh.*
Bulla ?
Fusus.
Rostellaria macroptera, *Lamk.*
Voluta, two species.
Terebellum(Seraphs)convolutum,*Lamk.*
Lenita patelloides, *E. Forbes.*
Nucleolites patelloides, Galeotti.
Asterias.
Myliobates.
Lamna.

These fossils show clearly that we have here such an assemblage as belongs to the beds which in England and France contain *Nummulites lævigatus*.

After examining the numerous sections exposed in other parts of the Hill of Cassel, I could find no *fossiliferous* strata older than those above enumerated. Next to the sands already mentioned are green and yellowish sands and clays, which form the upper part of the *Système Ypresien* of Dumont, but in which I could not detect the usual fossil, *Nummulites planulatus*.

Still lower, a vast thickness of brown clay (F 1, fig. 4), corresponding to the London Clay, has been bored at the railway station to the depth of 100 metres, or 320 English feet, without the bottom being reached.

In naming the above fossils of Cassel, a great part of which are unfortunately in the state of casts, I had the advantage of M. Nyst's assistance, whose collection of Belgian species is most extensive and whose palæontological skill is well known. In comparing them since with British fossils, I have been assisted by Mr. Morris. A general list of the whole is given in Table XIII. p. 351, where two columns are devoted to them, entitled "Upper" and "Lower." The "Upper" column refers to those shells of the Hills of Mont Noir and Cassel which belong to strata decidedly above the "*Nummulites lævigatus* bed." The "Lower" refers to the Cassel shells which belong to the bed last mentioned, and to the other fossiliferous strata of sand and green marls above enumerated as occurring in the Hill of Cassel.

I have omitted the Boeschepe shells in Table XIII., as their position was not positively ascertained, although, for reasons before stated, I should place them in the "Upper" column.

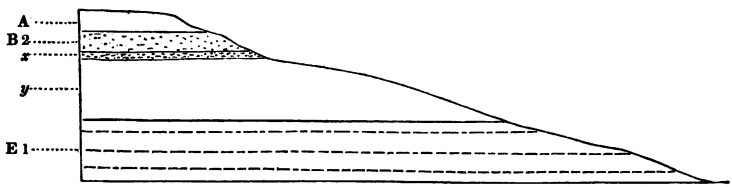
2. *Middle Eocene Strata of Brussels.*

[1.] *Laeken beds. Dileghem, Jette, Laeken, &c.*

I shall now pass to the neighbourhood of Brussels, the most important of the districts after Cassel, where I had an opportunity of studying the Middle Eocene strata. The capital of Belgium is distant from Cassel about seventy-five English miles, in a straight line due east. In exploring its environs I had the great advantage of being accompanied by my friend Captain Le Hon, who had made a fine collection of tertiary fossils, and whose accurate knowledge of palæontology enabled him to render me the greatest assistance. We visited together most of the localities which I shall have to mention. M. Déby also of Brussels accompanied us in many of our excursions, and gave us much information respecting the geological structure of the country.

The general level above the sea of the higher grounds or table-lands round Brussels is about 300 feet, the valleys which intersect them cutting to the depth of 200 feet and upwards, so as to descend to within 60 and 70 feet of the sea-level. On the highest grounds, and at many intervening elevations, loess is found (see Section, fig. 6).

Fig. 6.—*Section near Dileghem, two miles N.N.W. of Brussels.*



A. Loess.
B 2. Diest sands.
x. Bed of rolled flint-pebbles.
y. Yellow and green sands.
E 1. Laeken beds.

Thus, near Dileghem, two miles N.N.W. of Brussels (Map, fig. 3, Pl. XVII.), it may be seen crowning the elevated platform (fig. 6, A). Next in order iron-sandstone and green sands, exactly resembling those of Diest (B. 2. fig. 6), about 10 feet thick, below which is a bed of well-rolled flint-pebbles (*x*, fig. 6). Under this, yellow ferruginous sands (*y*, fig. 6), with hydrate of iron and green sands, 30 feet thick, and without shells, succeed. I had no means of determining their age, whether they are contemporaneous with the beds of Mont Noir near Cassel, before described as containing Middle Eocene fossils, or whether they are part of the Limburg series, as I was assured by several Belgian geologists.

At a somewhat lower level, sands, containing unquestionable Eocene fossils, are seen in the fields at the points marked A. and B. in Map, fig. 3, Pl. XVII., but their contact with the incumbent beds, *y*, fig. 6, is not exposed. Scattered over these fields, which are often called indifferently "Jette" and "Laeken" by collectors of fossils, and also in a sand-pit from which shelly matter had been extracted for agricultural purposes, I found *Cytherea suberycinoides, Pecten corneus,*

Scalaria spirata, and *Nummulites variolarius*. The fossils obtained from the same beds by Captain Le Hon amount to the number of 76, and are enumerated in the column "Upper Brussels," Table XIII. p. 351. The following twenty species are among the more common, and the numbers appended, as furnished by Captain Le Hon, express their relative abundance.

Operculina Orbignyi	3	Pectunculus pulvinatus	3
Dactylopora cylindracea ?	2	Stalagmium Nystii	4
Corbula rugosa ?	3	Pecten imbricatus ?	3
—— pisum	3	—— corneus	4
Crassatella trigonata	3	Dentalium substriatum	4
Lucina Galeottiana	1	Vermetus (Solarium) Nystii	4
Venus nitidula ?	4	Turritella granulosa	3
Astarte Nystiana	2	Bulla lignaria	1
Cardium semigranulatum	2	Natica glaucinoides	1
Cardita elegans	2	Scalaria spirata	1

From these data Professor E. Forbes infers that the deposit took place either in the lowest part of the perilittoral zone or the upper division of the median zone, perhaps in 20 fathoms water.

The strata of greenish and yellowish sands from which these shells were derived are from 10 to 15 feet thick, where I saw them exposed. At other points near Dileghem, nodular sandstone occurs, containing casts of shells, some of which were collected by M. Déby many years ago in pits no longer open. The specimens which he presented to me contained *Nummulites variolarius*, together with casts of *Lucina globosa* and *Pectunculus pulvinatus*.

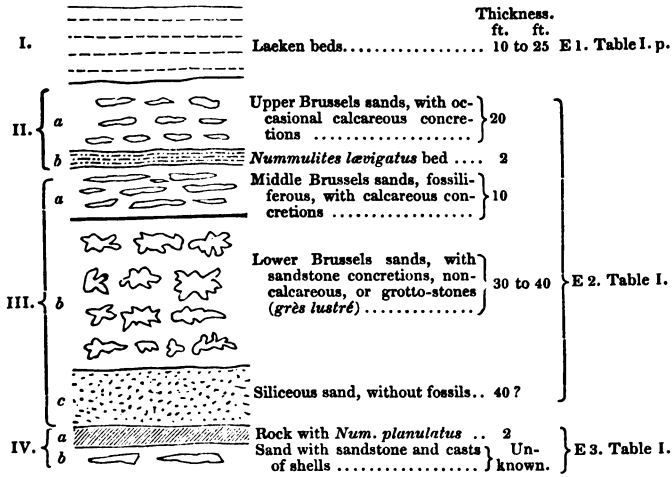
What I had seen at Cassel before my arrival at Brussels, and an examination of the section between Lille and Mons-en-Pevelle, which I shall mention in the sequel, had led me to conclude that the strata intervening between the Limburg series and the "London Clay proper" might be conveniently divided into three groups, distinguished among other characters by three different species of *Nummulites*,—*N. variolarius*, *N. lævigatus*, and *N. planulatus*. When I adopted this classification, I was not aware, or had forgotten, that the superposition of these three species in the order here assigned had been already recognized in the North of France, in 1842, by M. d'Archiac in his paper on the Department of the Aisne (Mém. de la Soc. Géol. de France, tom. v.). After my return from Belgium, when visiting Cuisse-Lamotte near Compiegne in France, I saw the shelly sands called "*sables inférieurs*" with *Nummulites planulatus*, surmounted by a nummulitic limestone, full of *N. lævigatus* and *N. scaber*, which is used as a building-stone at Mont Ganelon near Compiegne and other neighbouring places. Again, at Auvers, near Pontoise, north of Paris, I saw the lower *calcaire grossier* (or *glauconie grossière*), containing *Nummulites lævigatus*, and overlaid by sands (*sables moyens* or *grès de Beauchamp*) abounding in *N. variolarius**.

* Since my return from Brussels, M. d'Archiac has shown me, in a collection of fossils from Jette, a Nummulite which he could not distinguish from *N. planulatus*, mixed with *N. variolarius*. If the former species should be found to have endured down to the period of the "Laeken beds," its occurrence in them still appears to be an exception to the rule.

I must here take the opportunity of making a few remarks on the distribution of the three species of Nummulites, which are noticed in the text, in the English

After examining with Captain Le Hon the principal points where he had collected tertiary fossils in the neighbourhood of Brussels, I

TABLE XII. and Fig. 7.—*Subdivisions of the Middle Eocene Strata near Brussels.*



found it easy, with the aid of his museum, to subdivide the strata in Eocene beds,—a subject that has not as yet been satisfactorily treated, but towards the elucidation of which I have to offer the following facts:—

With Mr. Prestwich's kind assistance Mr. T. Rupert Jones has been enabled to examine the typical specimens of the Nummulites referred to in the list and description of the strata of the Alum Bay and White Cliff Bay Sections, published in 1846 (Quart. Journ. Geol. Soc. vol. ii. p. 252 *et seq.* and Pl. IX.); and this has led to the correction of some of the specific names there assigned to the Nummulites in question. By this examination Mr. Jones has found that in bed No. 11 of the White Cliff Bay Section (*i. e.* in the equivalent of part of the Bracklesham series), *Nummulites variolarius* (miscalled *N. elegans*, *loc. cit.* p. 254) occurs with *N. lævigatus* and *N. scaber*,—species which occur in two beds in contact with each other at Cassel, as above stated (see p. 329). In beds 12 to 14, still higher in the series, *N. lævigatus* and *N. scaber* alone occur (as is also the case at Bracklesham); and yet higher, in bed No. 16 (probably a member of the Barton group), *N. variolarius* (misnamed *N. elegans*, *loc. cit.*) occurs by itself, as in the uppermost division of the Nummulitic Eocene of France and Belgium. In the Barton Clay also (of Barton Cliff) *N. variolarius* is known to occur in great plenty and by itself, as well as at Stubbington.

There is also an important correction to be made in the list of fossils accompanying the description of the Alum Bay strata, *loc. cit.* p. 257, where two Nummulites are given as occurring in bed No. 29 (generally acknowledged to be the equivalent of the Barton beds). The specimens in Mr. Prestwich's collection, on re-examination, prove not to be, as there stated, *N. lævigatus* and *N. elegans*, but one form only, and that hitherto undescribed. This little Nummulite possesses characters distinct from those of *N. variolarius*, and somewhat approaches *N. planulatus*. In this circumstance we are reminded of the similarly anomalous position of the *Nummulites planulatus*, var. ? in the highest part of the Belgian Nummulitic Eocene, at Jette, as above noticed.

I have elsewhere referred (p. 350, note) to the existence of *N. planulatus* (*N. elegans*, 'Min. Conch.') at Emsworth, near Chichester. I may add that the rock-specimen in which it occurs is a siliceous grit, containing the Nummulite in great numbers, together with casts of small gasteropods and bivalves.

the same manner as at Cassel and Lille. There are, however, such rapid changes in the mineral character of the sands of the Brussels district, even at short distances, that it would be endless to attempt to describe them all. The groups enumerated in Table XII. must simply be understood as expressing some of the more marked lithological and palæontological divisions.

The Laeken beds, Table XII. I., and E. 1. of Table I., already alluded to as occurring to the north of Brussels, are again found about two miles to the south of the city, on the road-side between St. Gilles and Forêt, on ascending to the higher grounds at the point C, Map, fig. 3, Pl. XVII. They there consist of greenish sands, about 10 feet thick, which are considered by Captain Le Hon as the lowest part of the Laeken beds. In these I found

Nummulites variolarius, *Lamk.*
Turbinolia Nystiana, *Haime.*
Lunulites radiatus? *Lamk.*
Corbula pisum, *Sow.*
Cypricardia pectinifera, *Morris.*
Nucula margaritacea? *Martini.*
Pecten plebeius?, *Lamk.*
Anomia lævigata, *Sow.*
Ostrea flabellula, *Lamk.*
Dentalium Deshayesianum, *Galeotti.*
Turritella granulosa, *Desh.*
Echinocyamus propinquus, *Galeotti*, sp.

The position of these beds to the south of Brussels may be seen at E. 1, fig. 8, where they are covered by ferruginous sands without fossils (*y*), probably of the same age as those at *y* in Section fig. 6.

[2.] *Brussels beds, or Middle Nummulitic. Upper Brussels Sands.*

Next below the Laeken beds come those strata which are commonly called "Bruxellian" by the Belgian geologists, and which correspond to E. 2 of Table I. p. 279, and to II. *a* & *b*, Table XII. They consist of the Upper Brussels Sands, with a bed containing *Nummulites lævigatus* at the base. The chief points where fossils have been obtained in them are the following:—

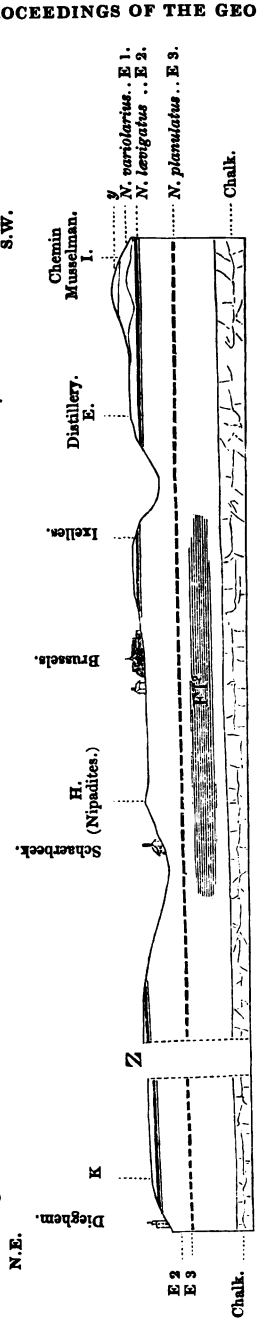
(1.) *St. Gilles. Chaussée Louise* (D. Map, fig. 3, Pl. XVII.).

In the southern suburb of Brussels, on the side of the high-road called Chaussée Louise, greenish sands are seen, which are from 15 to 20 feet thick at the point D of the Map, fig. 3, Pl. XVII., and exhibit two or three layers of large flattened concretions of sandstone, which effervesce with acids. The following fossils in Captain Le Hon's collection were obtained from this spot:—

*Nummulites lævigatus, *Lamk.* } in a bed at the base of the section.
*—— scaber, *Lamk.* }
Membranopora.
*Lichenopora.
*Orbitolites complanatus, *Lamk.*
*Lunulites radiatus?, *Lamk.*
*Idmonea triquetra, *Lamx.*
*Gastrochæna.
*Pecten plebeius, *Lamk.*
—— corneus, *Sow.*
*Anomia lævigata, *Sow.*
*Ostrea flabellula, *Lamk.*, and O. virgata, *Goldf.*
*Dentalium Deshayesianum, *Gal.*
*Spatangus Omalii, *Gal.*
*Echinolampas affinis?, *Goldf.*
*Lenita patelloides, *Galeotti*, sp.
Nucleolites approximatus, *Galeotti.*
*Cidarites?, sp. nov.
*Echinocyamus propinquus, *Gal.*
*Scutellina rotunda, *Gal.*
Cancer Burtini?, claws of.
——, smaller species.
Lamna, teeth of

The species marked with * occur also at the Distillery; *vide infra.*

Fig. 8.—*Section passing through Brussels along the Line of Section* I, K, *on the* Map, fig. 3, Pl. XIII.



y. Unfossiliferous sands.
E 1. Læken beds, or Upper Nummulitic.
E 2. Brussels beds, or Middle Nummulitic.
E 3. Lower Nummulitic beds.

Z. Break of several miles on the higher part of the platform south of Dieghem.
K, H, E, I. Points laid down in the Map, fig. 3, Pl. XVII.
The double line represents the *Nummulites lævigatus* bed.
The broken line represents the supposed place of the rock with *N. planulatus*, the position of which is ascertained at I. and H., or below the Schaerbeek quarry, by boring.
F 1 ?. London Clay ?, reached by boring at Brussels.
The chalk was found at the depth of about 250 feet below the river, in the outskirts of the city.

Note. The strata undulate more than is here expressed, but on the whole they appear to dip slightly to the north.

(2.) *St. Gilles. Fabrique d'eau forte* (E. Map, fig. 3, Pl. XVII., and Section, fig. 8).

Another locality where the upper Brussels sands immediately below the Laeken beds are seen with the *Nummulites lævigatus* bed at their base, is in the suburb called St. Gilles, at the Distillery "Fabrique d'eau forte," on the high-road to Waterloo. The fossils which I collected there, or which are in Captain Le Hon's cabinet, are first the seventeen species to which an asterisk is prefixed in the preceding list, and in addition, the two following:—

Scalaria, allied to *S. spirata*; perhaps a variety.
Cœlorhynchus rectus, *Agas.* (found by M. Nyst).

The bed (*Nummulites lævigatus* bed) on which the sands above-described repose at the "Fabrique d'eau forte," is full of a prodigious quantity of fish-teeth, much rolled, of the genera *Lamna, Otodus, Myliobates, Cœlorhynchus,* and *Edaphodon,* mixed with fragments of *Asterias.*

Among the fossil teeth in Captain Le Hon's collection, found at this spot, and in the same Nummulite-bed at several places in the neighbourhood, I have recognized the following species:—

Fossil Fish in the gravelly bed with Nummulites lævigatus.

Lamna elegans, *Ag.*
Otodus obliquus ?, *Ag.*
Pristis, resembling that figured in Dixon's 'Foss. Suss.,' pl. 10. fig. 6.
Myliobates Dixoni, *Ag.* Dixon, pl. 10. fig. 2, and pl. 12. fig. 3.
—— striatus, *Ag.* Dixon, pl. 12. fig. 2.
Edaphodon Bucklandi. Dixon, pl. 10. fig. 21.

Saurian from the Num. lævigatus bed.

Gavialis Dixoni ?, *Owen,* Dixon, pl. 12. fig. 24.

A single tooth, much resembling the figure above cited (a Saurian from the Eocene deposits of Bracklesham), was found by Captain Le Hon with the fish-teeth.

From the data supplied by Captain Le Hon respecting the relative abundance of the Echinoderms and Molluscs in the *Nummulites lævigatus* bed at this point, and in some other adjacent localities, Prof. Forbes infers the depth of the water to have been about 15 fathoms.

I observed at the same spot at St. Gilles a remarkable proof of the denudation of the underlying Eocene beds previously to the formation of the *Nummulites lævigatus* bed. A cast of *Rostellaria ampla* in a siliceous sandstone accompanies the Nummulites, and on some of the whorls (the shell itself having wholly disappeared) are seen two species of Bryozoa (*Escharina* and another) adherent. The small cells as well as their bases remain, and it is clear that they originally covered the surface of the cast after the shell itself had been dissolved.

(3.) *St. Gilles. Fort Monterey* (F. Map, fig. 3, Pl. XVII.).

In the parish of St. Gilles, near Fort Monterey, in a pit not far

from the toll-gate (where the road goes off to Forêt), the remains of a *Nautilus* (probably *N. Burtini*), with a cast of a large *Crassatella*, a *Tellina*, and several of the shells mentioned in the former lists, occur, with *Nummulites lævigatus*.

(4.) *Ixelles. South-east suburb of Brussels* (Map, fig. 3, Pl. XVII., and Section, fig. 8).

In a quarry at Ixelles, the same Nummulite-bed has afforded the following species:—

Nummulites lævigatus, *Lamk.*
—— scaber, *Lamk.*
Cardita planicostata, *Lamk.*
Pecten plebeius, *Lamk.*
——, another species.
Ostrea cariosa, *Desh.*
—— flabellula, *Lamk.*
Terebratula Kickxii, *Gal.*
Rostellaria ampla, *Brander.*
Bulla.
Nautilus, mandibles of.
Asterias (Goniaster poritoides?, *Desm.*).
Lamna.
Otodus.
Galeocerdo.
Myliobates.
Pristis Lathami, *Gal.*
Cœlorhynchus rectus?, *Ag.*

(5.) *Etterbeek, two miles east of Brussels* (Map, fig. 3, Pl. XVII.).

In a road-side quarry which I visited with Captain Le Hon, between Etterbeek and Woluwe-St.-Pierre, at the point G, Map, fig. 3, Pl. XVII., we observed the *Nummulites lævigatus* not forming a distinct bed, as usual, but disseminated through sands which contained the following fossils:—

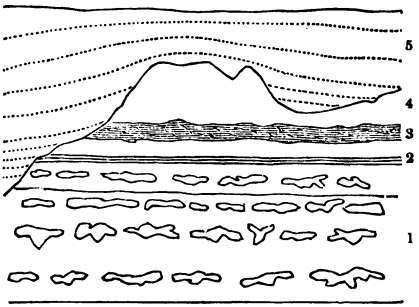
Nummulites lævigatus, *Lamk.*
—— scaber, *Lamk.*
Orbitolites complanatus, *Lamk.*
Flustra contexta?, *Mich.*
Bryozoon, small and branched.
Serpula, allied to *S. triquetra.*
——, two other species.
Gastrochæna.
Pecten plebeius?, *Lamk.*
Spondylus.
Anomia lævigata, *Sow.*
Ostrea inflata, *Desh.*
—— gryphina, *Desh.*
Ostrea cariosa, *Desh.*
—— virgata, *Goldf.*
—— flabellula, *Lamk.*
—— cymbula, *Lamk.*
——, sp. nov.
Terebratula Kickxii, *Gal.*
Crania Hoëninghausii, *Michelotti.*
Dentalium (Ditrupa) Deshayesianum, *Gal.*
Asterias (Goniaster poritoides?, *Desm.*).
Echinolampas affinis?, *Goldf.*, sp.
Spatangus Omalii, *Gal.*
Cœlorhynchus rectus, *Ag.*

(6.) *Dieghem, seven miles north-east of Brussels.*

It will be seen by reference to Section, fig. 8, p. 336, that the city of Brussels stands, for the most part, on the beds which are next below that containing *Nummulites lævigatus*; but in following the line of section (I, K, Map, fig. 3, Pl. XVII. and fig. 8) to Dieghem, seven miles north-east of Brussels, this bed is exposed to view in the quarries there with the usual fossils, although its thickness does not exceed 2 feet. It is for the most part covered immediately with white calcareous sand, belonging to the beds E, which, like the Nummulite-bed, have been much denuded. Over both are newer yellow sands and pebbly beds, the age of which I could not determine for want of organic remains. The manner in which the nummulitic bed, and the

Eocene strata immediately overlying and underlying it, have suffered denudation (sometimes to the depth of 20 and 25 feet), is shown in the annexed diagram.

Fig. 9.—*Section at Dieghem, seven miles N.E. of Brussels.*



1. Siliceous sand with layers of grotto-stones, E 2, Table I., or III. *b*, Table XII.
2. Siliceous schist or tripoli.
3. *Nummulites lævigatus* bed, with *Crania*.
4. White sand, II. *a*, Table XII.
5. Newer sands, 25 feet thick.

All the peculiar characters of the Nummulite-bed, already described as belonging to it round Brussels, are repeated in this quarry. It may be termed a gravel-bed, with quartz-sand, pebbles, and rolled fragments (generally small, but occasionally of a large size) of a rock formed of aggregated remains of *Nummulites lævigatus*, which after having been consolidated must have been broken up. On these fragments partially rounded, and often several inches in diameter, are numerous adhering shells, of the genera *Ostrea*, *Spondylus*, and *Crania*, also *Serpulæ* and several *Bryozoa* attached to pebbles or to the valves of molluscs. *Terebratula Kickxii* likewise occurs in this bed, but no univalve shells. The presence of the *Crania*, so rare in tertiary strata, is interesting. The same shell had been observed by Captain Le Hon at Etterbeek, as already mentioned, before I visited Dieghem. Mr. Davidson considers this species inseparable from *Crania Hoëninghausii* of Michelotti*. The shells are of the same size, and, although his figures are small, they offer the same characters as the Belgian shell, which, Mr. Davidson remarks, is less conical than D'Orbigny's *Crania cenomanensis*, which it most resembles. Whether the tertiary beds at Turin, from which Michelotti obtained his specimen, agree in age with those of Brussels, I cannot decide.

A magnified representation of this *Crania* is given in Pl. XVIII. fig. 8, and the following description has been drawn up by my friend Mr. Davidson.

CRANIA HOËNINGHAUSII, Michelotti, 1847. [Pl. XVIII. fig. 8.]

Shell irregular, inæquivalve, transversely oval, slightly conical,

* Hill of Turin. Fossiles des Terrains Miocènes de l'Italie Septent. 1847, p. 79, pl. 2. fig. 23, 24.

patelliform, depressed; vertex almost central; surface exteriorly unequal and rugose. Interior of upper valve (the only one known) concave, margin narrow, granulated. Four muscular impressions; the posterior ones are more or less circular, lying close to the inner edge of the granulated margin, and separated from each other by a flat space not equal in size to one of the muscular impressions; the anterior pair are irregularly oval, diverging from near the centre towards the posterior lateral margin: a slight prominence existing before the central pair. Vascular impressions not well defined. Structure punctuated. Length 4 lines. Breadth 4½ lines. Depth 1 line.

Locality. Eocene beds of Dieghem, near Brussels, and in the beds of the Hill of Turin.

Fossil Echinoderms.

In the foregoing lists of fossils from the Upper Brussels sands, the names of six species of Echinoderms have been enumerated; and I have mentioned, besides, the *Echinolampas Galeottianus*, as found a few feet above the Nummulite-bed at Cassel. Excepting *E. affinis?*, figures of all these are given in Pl. VIII.; and Professor E. Forbes has had the kindness to draw up the following descriptions.

Note on the Eocene Echinoderms *procured by* Sir Charles Lyell *in* Belgium. By Professor E. Forbes, F.R.S., F.G.S.

In M. Galeotti's Memoir on the Geology of Brabant, he enumerates eight species of fossil sea-urchins, and figures seven of them as new, but without detailed descriptions. The figures are very slight, and, in the present state of the subject, insufficient. Additional representations of these interesting fossils are, therefore, much to be desired, and some additional information respecting their characters cannot fail to prove useful.

Sir Charles Lyell has submitted to my examination seven tertiary Sea-urchins from Belgium (exclusive of *Echinolampas affinis?*). All but one among these appear to be identical with Galeotti's species. They are represented in Pl. VIII. of this volume.

Echinolampas Galeottianus, n. sp. Pl. VIII. fig. 1, *a*, *b*, *c*.

These figures represent an *Echinolampas* not included in Galeotti's list. It was found in abundance by Sir Charles Lyell in the Hill of Cassel, near Dunkirk, and named for him by some of the Belgian naturalists, *Clypeaster* (i. e. *Echinolampas*) *affinis* of Goldfuss. It differs in some material points from the figure of that species in the 'Petrefacta Germaniæ,' and, as several very perfect specimens have been submitted to my examination, all of which exhibit the same features, I feel warranted in regarding them as examples of a distinct form of this genus, and to which, as the species appears to be undescribed, I would assign the name of *Echinolampas Galeottianus*.

A large example measures 2½ inches in length by $2\frac{5}{10}$ths in breadth. Its greatest thickness (somewhat in front of the apex) is $\frac{10}{12}$ths of an

inch. Above it is regularly convex, with the apex eccentric and anteal. In front of the apex, the anteal ambulacral region is declining and depressed, but forms a tumid curve before reaching the margin. Behind it the back rises gradually and describes a regularly swelling but rapidly declining curve, until it reaches the posterior margin. The ambulacral petals of the back are lanceolate; that of the anteal ambulacrum is nearly symmetrical; the lateral ones are slightly inequilateral; the postero-laterals are slightly longer than the antero-laterals. They diverge at a considerable angle, and their extremities do not approach the margin so nearly as those of the antero-laterals. There are about fifty-two pairs of pores in each row in the anteal ambulacrum, and seventy or more in the lateral. They are placed in very slight depressions, and the pores are connected by grooves, separated by narrow granulated ridges. The whole surface of the test above and below is studded with nearly equal minute tubercles, lodged in areolæ. The mouth is very eccentric, and the buccal ambulacra are separated by swellings of the test. The vent is infra-marginal and transversely ovate.

It differs from *Echinolampas affinis* in having a compressed (not tumid) margin, in regularly declining with a gentle curve in its posterior region, and in having its mouth much more eccentric.

ECHINOLAMPAS AFFINIS?, Goldf. sp. [Not figured.]

A specimen of *Echinolampas*, from the neighbourhood of Brussels, was presented to Sir C. Lyell by Captain Le Hon, with the name of *Galerites ovalis*; this may, perhaps, prove to be the *Clypeaster affinis* of Goldfuss.

ECHINOLAMPAS DEKINI, Galeotti, sp. Pl. VIII. fig. 2, *a*, *b*, *c*.

This is the *Galerites Dekini* of Galeotti, pl. 4. *b*, Suppl., fig. 10. It is a good species, with a tumid test, much swollen throughout the posteal region. Its apex is very eccentric. The petals are lanceolate and not strongly marked; the two postero-laterals are longest. The tuberculation of the surface is equal and minute. The mouth and vent are both transverse; the former eccentric and lodged in a depressed area, with tumidities surrounding it. The figure represents this specimen of the natural size.

NUCLEOLITES APPROXIMATUS, Galeotti. Pl. VIII. fig. 3, *a*, *b*, *c*.

The specimen of this rare fossil is unfortunately in bad condition. It appears to be a true *Nucleolites* and is exceedingly interesting, since it is the only tertiary example of the genus with which I am acquainted having an anal groove; it thereby in some respects helps to fill up the gap between the cretaceous *Nucleolites* of this division and the unique existing *Nucleolites recens* of the seas of New Holland.

ECHINOCYAMUS PROPINQUUS, Galeotti. Pl. VIII. fig. 4, *a*, *b*, *c*.

This appears to be a good species, but in this genus it is very difficult to find good characters. The position of the vent, away from the margin, reminds us of the existing *Echinocyamus pusillus*.

SCUTELLINA ROTUNDA, Galeotti, sp. Pl. VIII. fig. 5, *a*, *b*, *c*.

This is *Nucleolites rotundus* of Galeotti. It is a species of *Scutellina* and approaches very nearly to *S. placentula* of the Parisian tertiaries.

LENITA PATELLOIDES, Galeotti, sp. Pl. VIII. fig. 6, *a*, *b*, *c*.

This is *Nucleolites patelloides* of Galeotti. Sir Charles Lyell received it from Capt. Le Hon as the *Lenita patellaris* of Goldfuss, but it differs from that species in having its vent placed very near to the margin, and in being more convex. In the group of sea-urchins to which it belongs, the position of the vent is very constant, and affords a certain indication of specific character. I regard it as a truly good species: it will stand as *Lenita patelloides*.

SPATANGUS OMALII, Galeotti. Pl. VIII. fig. 7, *a*, *b*.

The *Spatangus Omalii* of Galeotti is allied to the *Spatangus Hoffmanni* of Goldfuss. Galeotti represents a very bad and worn specimen, and omits the few large and scattered areolæ with their included primary tubercles that ornament the antero-lateral and lateral inter-ambulacral areas. The mouth is placed very far from the margin, and the anal extremity is abruptly truncated. It appears to be identical with fragments of a *Spatangus* found in the Barton beds by Mr. Frederic Edwards. The following revised description of this species may be serviceable:—

Test cordate, depressed; anterior furrow strongly marked and subcarinated at its sides. Ventral extremity abruptly truncated, with the anus placed moderately high up. Back slightly carinate. Dorsal ambulacra ovate; pores connected by wide sulcations. Antero-laterals widely diverging; postero-laterals meeting at an acute angle. Number of pairs of pores in a row, about 12 in the former and 14 in the latter. Areolæ very deeply impressed. Primaries confined to anterior and middle portions of test. A group of primary tubercles on each side of caudal projection. Mouth rather far from anteal margin. Ventral surface very flat.

[3.] *Fossiliferous Brussels Sands with calcareous concretions.* (III. *a*, Table XII. p. 334. Part of E 2, Table I. p. 279.)

Next to the *Nummulites lævigatus* bed we find, in the descending order, white sands which are in some places so calcareous as to have been burnt for lime in the suburbs of Brussels and at Dieghem, where I saw several kilns. These beds usually contain nodules of sandstone in layers, with casts of shells; sometimes the shell itself is present, either silicified, or, if it retain its calcareous matter, so decomposed as to fall to pieces when touched.

(1.) *Rouge Cloître, near Auderghem.*

At Rouge Cloître, near Auderghem, five miles south-east of Brussels, these calcareous beds, with some shells (silicified or in casts), are found about 4 feet thick, and have afforded the following shells which are in Capt. Le Hon's cabinet:—

Fossils from Rouge Cloître, near Auderghem, five miles S.E. of Brussels.

Turbinolia crispa, *Lamk.*
Polyparia.
Corbula umbonella, *Desh.*
*—— gallica, *Lamk.*
Mactra semisulcata, *Lamk.*
Tellina tenuistriata, *Desh.*
Lucina sulcata, *Lamk.*; abundant.
*—— divaricata, *Lamk.*; abundant.
—— gibbosa.
*Cytherea suberycinoides, *Desh.*; very abundant.
—— semisulcata, *Lamk.*
*—— lævigata, *Lamk.*
*Cardium porulosum, *Brander.*
——, another species.
Cardita.
Venericardia planicostata, *Desh.*
—— decussata, *Münst.*
Pectunculus (small).
Arca barbatula, *Lamk.*
Pecten corneus? *Sow.*
Anomia lævigata, *Sow.*
Ostrea virgata, *Goldf.*, or O. flabellula, *Lamk.*
Calyptræa trochiformis, *Lamk.*
Solarium grande? *Nyst.*
—— patulum? *Lamk.*
—— trochiforme, *Desh.*
Trochus conchyliformis (non *agglutinans*).
Turritella terebellata, *Lamk.*
Tornatella.
Natica spirata, *Bronn.*
—— patula, *Desh.*
—— sigaretina? ?, *Lamk.*
—— epiglottina, *Lamk.*
—— labellata, *Lamk.*
Sigaretus canaliculatus, *Sow.*
Fusus ficulneus, *Lamk.*
—— errans, *Sow.*
—— elongatus, *Nyst.*
—— bulbiformis, *Lamk.*
——, with long beak.
Pleurotoma?
Cerithium?
Pyrula.
Rostellaria macroptera, *Lamk.*
—— fissurella, *Lamk.*
Cassidaria carinata, *Lamk.*
—— nodosa? *Nyst.*
——, sp. nov.
Buccinum stromboides, *Herm.*
Conus deperditus, *Brug.*
—— turritus, *Lamk.*
Voluta cithara? *Lamk.*
Oliva.
Sepia Cuvieri, *d'Orb.*
Beloptera?
Lamna, teeth.
Vertebræ of Shark and other Fish.

(2.) *St. Joose-ten-Noode.*

At this locality, in the eastern suburbs of Brussels, are some pits near the high-road to Louvain, in which many fossils have been obtained, agreeing for the most part with those of Auderghem. Those five species, for example, to which an asterisk is prefixed in the preceding list, occur at St. Joose-ten-Noode, and with them

Tellina rostralis.
—— planata, and another species.
Pinna margaritacea.
Murex tricarinatus.
Rostellaria(casts),probably R. fissurella.
Voluta (V. lyra or spinosa?).
Teeth of Lamna.
Myliobates.

One or two of these species, as *Tellina rostralis*, are shells usually confined to the Laeken beds. At Groenendal, three miles south of Brussels, many of the Auderghem shells are found in a ferruginous matrix.

(3.) *Schaerbeek.* (H, Map, fig. 3, Pl. XVII., and Section, fig. 8.)

The stone quarries at Schaerbeek, in the northern suburbs of Brussels, have long been celebrated for the fossil Fruits, called Cocoanuts, and for fossil Tortoises, found there in concretionary nodules. It

* The species to which an asterisk is prefixed occur also at St. Joose-ten-Noode.

will be seen by the section, fig. 8. p. 336, that the beds in this quarry are below the level of the *Nummulites lævigatus* bed.

In the principal quarry, the Middle Brussels beds (III. *a*, Table XII. p. 334), seen in the highest part of the section, consist of sands 10 feet thick, with several layers of stone. Some of these layers are almost continuous and afford flat paving-stones. These beds contain both argillaceous and calcareous matter, and in some of them occur the oval-shaped fossil Fruits (*Cocos Burtini*, Brongniart), referred to *Nipadites* by Mr. Bowerbank. Some of these are silicified, and the wood both of Palms and dicotyledonous trees are found in the same strata perfectly silicified.

At the time of my visit the workmen showed me the trunk of an exogenous tree with forty rings of annual growth, which they had just extracted. It had lain in a horizontal position and was bored by *Teredinæ*. Capt. Le Hon also possesses the stool of a Palm-tree, perfectly silicified, consisting of the base of the trunk, which seems to have been broken off short at about the level of the soil, and to which numerous air-roots or rootlets remain attached, such as palms very commonly throw out above the surface of the soil, the whole exhibiting structure beautifully preserved. Captain Nelson, to whom I showed this specimen (Capt. Le Hon having kindly allowed me to bring it over to England), recognized it as bearing a striking resemblance to what are called "palm-cups" in the West Indies. When an old cocoa-nut tree decays and breaks off near the ground, the central woody portion, which in endogenous trees consists of a spongy tissue, contracts more than the external or more solid wood, while the roots scarcely shrink at all. This produces a convexity in the middle, and may explain a similar cavity in the Schaerbeek fossil. The concave surface of the broken and shrunk wood exhibits a great number of small deep pits, caused by bundles of fibres having been pulled out when the fracture took place.

Nipadites, or the fossil Fruits of Palms.

The most interesting remains of fossil plants in the Schaerbeek quarries are those oval fruits already mentioned, which Burtin described in his 'Oryctographie de Bruxelles,' in 1784, and which he regarded as cocoa-nuts. They have been named by Mr. Bowerbank *Nipadites*, as being nearly allied to the *Nipa fruticans*, a palm which abounds in the delta of the Ganges and other parts of Bengal, and is the only living species of the genus known. M. Adolphe Brongniart has adopted the same generic name, and has observed that some of the fossil fruits of Brussels are sufficiently perfect to show that they want the ligneous endocarp marked by three pores, which is so characteristic of the cocoa-nut.

Mr. Bowerbank* enumerates thirteen species of *Nipadites* from the London Clay of the Isle of Sheppey, and considers that the Schaerbeek fossils, which Capt. Le Hon kindly lent me to figure, belong to no less than four of his British species; viz.—

* 'Fossil Fruits and Seeds of the London Clay,' 1840.

1. Nipadites turgidus, *Bowerbank*, '*Fossil Fruits*,' pl. 5. [Pl. XIX. fig. 1, & Pl. XX. figs. 7, 8.]
2. N. giganteus, *Bowerbank*, pl. 6. fig. 1. [Pl. XIX. fig. 2.]

} *Nipadites Burtini*, (according to Dr. Hooker).

3. N. lanceolatus, *Bowerbank*, pl. 3. fig. 7 & 8. [Pl. XIX. fig. 3, 4.]
4. N. Parkinsonis, *Bowerbank*, pl. 4. [Pl. XIX. figs. 5, 6.]

The first two of these are considered by Dr. Hooker as probably belonging to the same species, which should be called *Nipadites Burtini*, Brongn. sp. Many of Mr. Bowerbank's species, as he is now aware, may be founded on differences which appertain to individual varieties, or are still more frequently the result of different stages of growth, and of pressure in fruits aggregated into bunches. They were selected by him as the most striking and constant forms out of many hundreds of individuals from Sheppey.

Nipadites Burtini, Brongniart, sp.
[Pl. XIX. figs. 1, 2, & Pl. XX. figs. 7, 8.]

Length of the largest Schaerbeek specimen, 7 inches $\frac{5}{10}$ths; breadth 4 inches.

Fig. 1 represents a ripe specimen called *N. turgidus* by Mr. Bowerbank. Burtin's figure, pl. 30. fig. A, is good, but Capt. Le Hon's specimen (here figured) displays more fully the texture and form both of the pericarp and its contained seed.

Pl. XX. fig. 7. Side view of another specimen, showing the marks of boring Molluscs, probably *Teredinæ*.

Pl. XX. fig. 8. Base of the same specimen, broken off at *a*, fig. 7, showing hollows made by *Teredinæ* and filled by sandstone, the cavity of the pericarp being similarly filled (*a*, *b*).

Pl. XIX. fig. 2. *N. giganteus*, Bow., is according to Dr. Hooker an immature or abortive fruit of the same species, showing the angularity of the pericarp, equally characteristic of this and of the ripe specimen. From the sharpness of the prominent ridge and the gibbosity of its general shape, the fossil singularly resembles the living *Nipa fruticans*, with which it also agrees in the coarsely fibrous texture of the pericarp.

Dr. Hooker has shown me seeds taken from the same head of *Nipa fruticans*, from the Sunderbunds of the Ganges, differing much more widely from one another in form and outline than *N. turgidus* and *N. giganteus*. One of the recent specimens is not so much as one-fifth the size of another in the same bunch.

Some of Mr. Bowerbank's specimens from Sheppey are not inferior in size to those of Brussels. If the nuts were equally numerous in the same head, a cluster of them must have very far exceeded in magnitude the head of the living *Nipa*. The absence of nuts in many of the full-grown pericarps at Schaerbeek is quite natural, as I learn from Dr. Hooker that the top seed-vessels are most commonly abortive in the living *Nipa*, as are frequently some of those in the rest of the bunch.

Several of the Schaerbeek fruits are drilled by *Teredinæ*, and have the pericarp silicified.

NIPADITES LANCEOLATUS, Bowerbank, pl. 3. fig. 7, 8, and N. CLAVATUS?, Bowerbank, pl. 3. figs. 4, 5, 6.

[Pl. XIX. figs. 3, 4.]

Fig. 3 represents a fruit split open, exposing the cast of the pericarp (*a*) and a cast of the nut, or of its cavity (*b*), bearing an impression of the endocarp.

Fig. 4 is a lateral or edge-view of this same body or nucleus, removed from the pericarp, and shows the point of attachment at its base. There are no remains of vegetable tissue in any part of the specimen.

NIPADITES PARKINSONIS, Bowerbank, sp. (pl. 4).
Cocos Parkinsonis, Ad. Brongn., Prodrome, p. 121.

[Pl. XIX. figs. 5, 6.]

Length of Schaerbeek specimen 1 inch $\frac{4}{10}$ths, breadth 1 inch $\frac{1}{10}$th.

Fig. 5 *a*.—Cast of the outside of the pericarp.

Fig. 5 *b*.—Nucleus or cast of the endocarp or inner surface of the pericarp. In this, as in other specimens, the nucleus resembles the seed in form, but is without trace of tissue.

Fig. 6.—Another view of the nucleus, showing the opening where the sand entered at the base.

All the above figures are reduced to half the length of the fossils.

HONIUM BRUXELLIENSE.

[Pl. XX. fig. 1–6 *b*.]

I have given to this curious fossil from Schaerbeek, which I am inclined to consider a Sponge, the generic name of *Honium*, from its discoverer Captain Le Hon. Many conjectures have been formed by palæontologists as to its true nature, some having suggested that it may prove to be part of the spadix or catkin of some cycadeous plant, as, in their opinion, it was composed chiefly of cellular tissue. But Dr. Hooker tells me he has never seen in any plant such reticulated structure as is exhibited in part of the *Honium*, so that he is opposed to the opinion of its being of vegetable origin. It may perhaps be allied to a Sponge, as it contains many spines which agree in form with the *spicula* of Sponges: but we can scarcely be sure that such spines really belong to the fossil, because both specimens of the *Honium* figured in Pl. XX. contain many spines of an Echinoderm, which are certainly foreign to the body itself, and many of which may be seen scattered through the rock, although nowhere in such thick clusters as on one of the specimens of *Honium*. A small portion of the cast of the test of a *Spatangus*, however, is preserved in one of the stones containing *Nipadites*, from the same stratum at Schaerbeek, showing the co-existence of Echinoderms with the *Honium*.

The convergence of the lines of pits in the reticulation towards

the peduncle appears to Dr. Hooker to be unlike plant-structure. Some Sponges, on the other hand, offer a similar appearance.

Pl. XX. fig. 1. represents this fossil, of the natural size. It is a cast of a transversely obtuse-oval body, with a sinus on its upper or longer edge, and opposite to this a stem-like tapering projection or peduncle. This surface of the cast is convex, and the other surface, on the corresponding fragment of the nodule, which has not been preserved, was probably parallel to it, a slight cavity intervening; traces of a furrow at the margin of the cast (fig. 5 *a*) remain to indicate the thickness of the blunt edges of the *Honium*, which was probably less than $\frac{1}{10}$th of an inch. The stem or peduncle was continued into the body, as shown by a granular ridge upon the surface of the cast; in other words, a thin ridge runs from about the centre of the surface of the body down towards the peduncle. Imbedded in the surface of this specimen are seen clusters of *spicula*; and a small portion of it retains a reticulated surface, which is still better shown in the specimen fig. 2, where at one spot the reticulation passes over the spines.

Pl. XX. fig. 6^a and 6^b.—Magnified representations of the *spicula* from the above-described specimen, fig. 1; *a*, and *c*, *c*, *Spicula* of Sponge?, *b* and *d*, Spines of a *Spatangus*.

All of these are more or less coated with the same earthy matter which cements the sandstone in which they are imbedded. The grains of sand being enveloped with the same calcareo-siliceous cement, are thus often joined to the *spicula*, and when these grains happen to adhere to the end of a *spiculum* they give it the appearance of a spine with a bulbous base. The *spicula* vary in length from $\frac{1}{10}$ to $\frac{1}{12}$ inch.

Fig. 2. (Natural size.)—Another specimen of *Honium*. Only a few *spicula* are dispersed over it, and the surface is nearly covered by a fine network.

Fig. 3.—A portion from near the centre of the surface of fig. 2, magnified.

Fig. 4.—Another portion from the central part of the same specimen, showing the reticulated surface, *b*, converging towards, and passing under the granular ridge, *a*.

Fig. 5, *a*.—Magnified representation of part of the surface at the edge near the stem, on the right-hand side of fig. 2.

Fig. 5, *b*.—Portion of the surface in the sinus (fig. 2), where the network assumes the aspect of a wrinkled membrane, or of a membrane to which a cellular tissue has been attached, the rest of the tissue being destroyed.

Patches of a black, carbonaceous, pulverulent matter stain the hollows in both specimens.

It appears that the stony beds at Schaerbeek (III. *a*, Table XII. p. 334), which contain the above-mentioned *Honium* and *Nipadites*, with much fossil wood of palms and dicotyledonous trees, were formed in the sea, near the mouth of a river, as in the case of the clay at Sheppey; and the fruits prove that the same species of *Nipadites* which flourished at the period of the London Clay proper continued

to abound at an era more nearly corresponding with that of the Bracklesham beds. I have already mentioned that in the Hill of Cassel I found *Nipadites*, bored by *Teredinæ*, at a somewhat higher geological level, or in the beds containing *Nummulites variolarius* (see p. 328). Teeth of Sharks occasionally occur in the same beds with the Fruits at Schaerbeek, together with *Ostrea flabellula* and a *Pinna* (*P. margaritacea*?), showing that the water was salt; while the influence of a river is attested by the occasional presence of fresh-water Tortoises. One of these, obtained by Captain Le Hon, exhibits a perfect carapace, 1 foot long by 10 inches in breadth, and is probably the *Emys Cuvieri*, Galeotti, figured by Burtin. According to Professor Owen, to whom it has been submitted, it is a perfect cast of the inner surface of the carapace, with the hinder marginal plates dilated, but in no part showing the scutation; so that the species could not be determined, although it may be pronounced to be "a freshwater or estuary Emydian."

I learn from Captain Le Hon that the marine Fish, figured by Burtin in his 'Oryctography of Brussels,' plates 3 and 4 (*Zeus auratus*, Blainville, and *Pleuronectes maximus*, Blainville), occur at the same level as the *Nipadites*, *Honium*, and Emydian Tortoise above-described.

At Saventham, near Brussels, fossils similar to those at Schaerbeek are found in a like position.

[4.] *Lower Brussels Sands with "grotto-stones,"* &c.
(III. *b*. Table XII. p. 334.)

The calcareous bands (III. *a*. Table XII.) last mentioned are about 10 feet thick. Below them, at Schaerbeek, other sands are found, 40 feet thick, with many layers (not less than twenty) of irregularly-shaped nodules of sandstone, called *pierres de grottes* or *grès lustré*, from the shining glossy lustre of the fractured surface. They consist of aggregations of siliceous sand with a siliceous cement, such as that which has petrified the fossil trees. The interior of a nodule is often a cherty mass. The shapes of these stones are extremely irregular, and sometimes quite grotesque. Sharks' teeth and shells, especially *Ostrea flabellula* and *O. virgata*, are seen half-entangled in the solid mass and half-projecting from the surface of the nodule, the loose sand having fallen away from the exterior. Besides the more regular beds of grotto-stones some scattered concretions occur, resembling the branches of trees in shape. From the abundance of these in certain districts the name of *grès fistuleux* has been given to this division, III. *b*.

Below these beds are the sands III. *c*, which consist of white siliceous sands without fossils; and below these a stratum of rock with *Nummulites planulatus* has been found by boring at Schaerbeek at the depth of 70 feet, to which I shall presently allude.

[5.] *Dieghem Schistose Tripoli.* (Table XII. III. *a*, and fig. 9, p. 339.)

In the Dieghem quarries already mentioned, which are above 60 feet in depth, immediately under the *Nummulites lævigatus* bed I found continuous beds of siliceous or cherty stone, 4 feet thick, one of which

is a fissile slate more than half made up of siliceous sponge-spicules (curved, straight, and forked) and siliceous casts of minute Foraminifera of the genera *Textularia, Nonionina, Triloculina, Rosalina* (a species near to, if not identical with, *R. Beccarii*). This peculiar siliceous schist or tripoli is of very slight specific gravity. Some silicified Wood and remains of Chelonians have also been found in the associated stony layers at Dieghem.

Beneath this siliceous schist, sands, 40 feet thick, with twenty-five layers of *grès lustré* or grotto-stones, occur. The quantity of stone in nodules seems to increase as we proceed northwards from Brussels, but scarcely any fossils are found in it.

[6.] *Cerithium giganteum.*

This shell has been obtained from Afflighem, near Assche (see Map, fig. 1, Pl. XVII.), N.W. of Brussels, from a quarry no longer open, which formerly furnished building-stone for the construction of a neighbouring abbey. In the same stone are seen *Lucina mutabilis, Turritella intermedia,* and *Nautilus Burtini.* Whether its position was in II. of Table XII. (the *Nummulites lævigatus* division) or in III., I could not ascertain.

3. *Sands with Nummulites planulatus. Lower Nummulitic ; Middle Eocene.* (E. 3, Table I. p. 279, & IV. *a*, Table XII. p. 334.) *Système Ypresien, étage supérieur,* of M. Dumont.

[1.] *Lower Nummulitic in the neighbourhood of Brussels.*

The only spot near Brussels, where I saw several bands of stone, consisting of an aggregate of *Nummulites planulatus,* exposed in a natural section, was about three miles south of the city, near Forêt, in a deep lane near the country-seat of M. Musselman (see Section, fig. 8. I. p. 336, and Map, fig. 3. I. Pl. XVII.). I examined this section with Capt. Le Hon, and we observed there within a very short distance all the strata from the lower nummulite-beds (*N. planulatus*) to the Laeken sands inclusive. At the bottom of the lane several layers of stone are seen, containing casts of *Cardium, Cytherea,* and other shells, which appear to underlie the nummulite-bed. But this part of the section is obscure, and there are signs of disturbance, as if a fault had brought down some strata higher in the series to the level of the Lower nummulitic rock. The *Nummulites planulatus* extends through a thickness of about 10 feet of sand, in part glauconiferous, and in the midst of which are some solid bands of aggregated Nummulites. At a higher level the calcareous sands (III. *a*, Table XII.) are distinctly seen, then the *Nummulites lævigatus* bed, separated by a thickness of 70 feet of strata from the lower sandy and stony deposits containing *N. planulatus.* All the beds have a decided dip, and are inclined at a steeper angle than any other which I saw round Brussels. At a higher elevation, in the road from Forêt to St. Gilles, the greenish sands of the lower part of the Laeken beds occur with *Nummulites variolarius* and other fossils before enumerated, p. 335.

I have before stated that in the quarry at Schaerbeek an Artesian

well was excavated, beginning in the "grotto-stones" (III. *b*.) and reaching, at the depth of 70 feet, the bed with *N. planulatus*, below which water was obtained. There seems to be an average thickness of about 100 feet of strata between the two nummulite-beds and II. *b*. and IV. Table XII., but it is very variable. It may be well to remark here, that all the fossils figured by Burtin in his 'Oryctographie de Bruxelles,' 1784, were obtained within these limits, or between the gravel containing *N. lævigatus* and the continuous bands of rock with *N. planulatus**.

In the lowest part of the suburbs of Brussels, near the Pont Léopold, several wells have been sunk, at about 20½ metres or 67 English feet above the level of the sea. They passed, first, through alternations of clay and sand (*N. planulatus* or *Ypresien* division?), continuing to the depth of 50 metres, or 165 feet, below which they came to a mass of clay (London clay proper?, see Section, fig. 8, p. 336), with a thickness of from 20 to 30 metres (65 to 100 English feet). About 200 feet below the level of the sea they reached the White Chalk with flints, there being, as usual, a parting layer between the tertiary and secondary series containing rolled flints with a green coating. The exact age of the beds here pierced I could not ascertain, as no fossils had been collected.

Before concluding my remarks on the environs of Brussels, I have thought it useful to insert a list or synoptical Table of the organic remains which have been mentioned in the preceding pages, distinguishing those found in the Laeken beds as an "upper" division, and those occurring in strata below (Upper and Lower Brussels Sands), as a "lower" division, but not including the *Nummulites planulatus* rock. In the same Table I have introduced (as mentioned p. 331) the fossils from the Hill of Cassel, divided in like manner into—1st, those above the level of the stratum abounding in *N. lævigatus*, and 2ndly, those below. I was not able in either of these districts to obtain sufficient information respecting the division containing *N. planulatus*, to add a separate column for its characteristic organic remains.

For the Brussels lists I am indebted chiefly to Capt. Le Hon, who enabled me to compare a large number of his species with British fossils. The Cassel shells were collected by myself, and named, as already stated, with the aid of MM. Nyst, Morris, and others.

The last column indicates the localities where the same species occur in England or France. In cases where I was acquainted with an English locality I have not inserted "Calc. gross.," Mr. Prestwich having shown the close affinity between the fossil fauna of Barton and Bracklesham and that of the *Calcaire grossier*, including the *sables moyens* as its upper division.

* Mr. T. Rupert Jones informs me that the Nummulite figured as *N. elegans* in the 'Mineral Conchology' from specimens marked "Emsworth, near Chichester," and which Mr. J. de C. Sowerby has kindly permitted him to examine, is (as suggested by M. d'Archiac, 'Hist. Prog. Géol.' vol. iii.) undoubtedly the *N. planulatus* of continental geologists. It is probable, therefore, that in that part of England where the Bracklesham beds with *N. lævigatus* are so largely developed, strata characterized by *N. planulatus* also exist; and it is highly desirable that their relative position should be carefully studied.

Table XIII.

Middle Eocene Fossils from Cassel, near Dunkirk, and from Brussels.

[In the last column of this Table, B. means Barton; Br., Bracklesham; L., London Clay proper; Calc. gr., *Calcaire grossier*; Sab. m., *Sables moyens*, or the upper part of the *Calc. gross.*; Sab. inf., *Sables inférieurs* with *Num. planulatus*.]

	Cassel.		Brussels.		Other localities.
	Upper.	Lower.	Upper.	Lower.	
Nipadites Burtini, *Ad. Brongn.* ..... *N. turgidus*, Bowerb. *N. giganteus*, Bowerb.	*	...	...	*	L.
—— lanceolatus, *Bowerb.*	...	...	...	*	L.
—— Parkinsonis, *Bowerb.*	...	...	...	*	L.
Honium Bruxelliense, *Lyell*	...	...	...	*	
Nummulites lævigatus, *Lamk.*	...	*	...	*	Br.
—— scaber, *Lamk.*	...	*	...	*	Calc. gr.
—— variolarius, *Lamk.*	*	...	*	...	B.?; Sab. m.
Orbitolites complanatus, *Lamk.*	...	...	...	*	Calc. gr.
Operculina Orbignyi, *Gal.*	...	...	*		
Miliolites	...	...	*		
Triloculina	...	...	...	*	
Textularia	...	...	...	*	
Nonionina	...	...	...	*	
Rosalina Beccarii?, *Linn.*	...	...	...	*	
Caryophyllia multistellata, *Nyst* ..... *Diphelia*, M.-Edw. and J. Haime.	...	...	*		
Turbinolia elliptica, *Brongn.*	...	...	*	...	Calc. gr.
—— crispa, *Lamk.*	...	...	...	*	Calc. gr.
—— Nystiana, *Haime* ..... *T. sulcata*, Nyst.	*	*	*		
——, sp. nov.?	...	...	*		
Idmonea triquetra, *Gal.*	...	...	...	*	
Dactylopora	...	...	*		
Flustra contexta?, *Mich.*	...	...	...	*	
Lunulites radiatus, *Lamk.*	*	...	*	*	Calc. gr.
——, another species	...	*			
Lichenopora	...	...	...	*	
Cellepora? petiolus, *Lonsd.* (Dixon)	...	...	*	...	Br.
Goniaster, fragments ..... *Asterias poritoides*?, Desm.	*	...	...	*	Calc. gr.?
Cidarites?, sp. nov.	...	...	...	*	
Echinolampas affinis?, *E. Forbes* ..... *Clypeaster affinis*?, Goldf.	*	...	...	*	Calc. gr.
—— Galeottianus, *E. Forbes*	*				
—— Dekini, *E. Forbes* ..... *Galerites Dekini*, Gal.	...	...	...	*	
Nucleolites approximatus, *Gal.*	...	...	...	*	
Lenita patelloides, *E. Forbes* ..... *Nucleolites patelloides*, Gal.	...	*	...	*	

TABLE XIII. (continued).

	Cassel.		Brussels.		Other localities.
	Upper.	Lower.	Upper.	Lower.	
Scutellina rotunda, *E. Forbes*	...	...	...	*	
Nucleolites rotundus, Gal.					
Echinocyamus propinquus, *E. Forbes*	...	...	*	*	
Echinoneus propinquus, Gal.					
Spatangus Omalii, *Gal.*	...	...	...	*	B.
Terebratula Kickxii, *Gal.*	*	*	...	*	
Crania Hoëninghausii, *Michel.*	...	...	...	*	
Clavagella tibialis, *Desh.*	*	...	...	...	Calc. gr.
—— coronata, *Desh.*	*	...	...	...	B.
Gastrochæna	...	*	...	*	
Solen	...	*			
Solecurtus parisiensis, *Desh.*	...	...	*	...	Br.; Calc.gr.?
Panopæa intermedia?, *Sow.*	...	*	...	...	L.
Corbula gallica, *Lamk.*	*	*	*	*	Br.
—— pisum, *Sow.*	*	...	*	...	B.
—— longirostris, *Desh.*	...	...	...	*	Br. B.
—— umbonella, *Desh.*	...	...	*	*	Sab. m.
Thracia?	*	*			
Mactra semisulcata, *Lamk.*	...	*	...	*	Calc. gr.
—— depressa?, *Desh.*	...	...	...	*	Br.
Crassatella trigonata, *Lamk.*	...	...	*	...	Calc. gr.
—— plicata, *Sow.*	...	...	*	...	B. Br.
—— compressa, *Lamk.*	...	...	*	...	Br.
C. Nystiana, D'Orb.					
C. tenuistriata, Desh.					
Sanguinolaria Hollowaysii, *Sow.*	*	...	...	...	Br.
Psammobia	...	*			
——, nov. sp.	...	...	*		
Tellina sinuata?, *Lamk.*	*	...	...	...	Calc. gr.
—— rostralis, *Lamk.*	*	...	*	...	Br.
—— textilis, *Edwards* (Dixon, pl. 3. fig. 1)	...	...	*	...	Br.
—— tenuistriata, *Desh.*	...	...	...	*	Br.
——, sp. nov.	...	...	...	*	Br.
—— plagia, *Edwards* (Dixon, pl. 3. fig. 5)	...	...	*	...	Br.
—— speciosa, *Edwards* (Dixon, pl. 3. fig. 2)	...	...	*	...	Br.
Lucina divaricata?, *Lamk.*	*	*	...	*	B.
—— mutabilis, *Lamk.*	*	*	...	...	Calc. gr.
—— contorta?, *Def.*	*	...	...	...	Sab. inf.
—— saxorum, *Lamk.*	...	...	*	...	B. Br.
L. mitis, Sow.					
—— Galeottiana, *Nyst.*	...	...	*		
—— sulcata, *Lamk.*	...	...	...	*	Calc. gr.?
—— gibbosula, *Lamk.*	...	...	...	*	Calc. gr.
Cytherea nitidula?, *Lamk.*	...	...	*	...	Br.
—— lævigata?, *Lamk.*	*	*	*	*	B.
—— suberycinoides, *Desh.*	*	*?	*	*	B. Br.
—— sulcataria, *Desh.*	...	...	*	...	B. Br.
Venus elegans?, *Sow.*	*	...	...	...	Calc. gr.
Astarte Nystiana, *Nyst.*	...	...	*		
Cypricardia pectinifera, *Sow.*	*	...	*	...	B.

TABLE XIII. (continued).

	Cassel.		Brussels.		Other localities.
	Upper.	Lower.	Upper.	Lower.	
Isocardia, sp. nov.	...	...	*		
Cardium porulosum, *Brander*	*	*	...	*	B. Br.
——, like *C. discors*, Lamk.	...	*			
—— semi-granulatum, *Sow.*	*	*	*	...	B. Br.
—— obliquum, *Desh.*	*	...	...	...	Calc. gr.
—— turgidum, *Brander*	*	...	...	...	B.
——, nov. sp.	...	...	*		
——, nov. sp.	...	...	...	*	
Cardita planicostata, *Lamk.*	...	*	...	*	Br.
—— decussata, *Lamk.*	...	*	...	*	Calc. gr.
—— elegans, *Lamk.*	*	...	*	...	Br.
—— acuticosta, *Desh.*	...	...	*	...	Br.
Nucula margaritacea, *Lamk.*	*	*	*	...	B. Br. L.
—— lunulata, *Nyst*	...	...	*	...	Calc. gr. ? Senlis.
—— striata, *Lamk.*	*	...	...	...	Calc. gr.
—— (Leda) Galeottiana, *Nyst.*	*	*	*	...	Calc. gr.
Pectunculus pulvinatus, *Lamk.*	...	...	*	...	Br.
P. Nystii, Gal.					
Pectunculus	...	*			
——, a small species	...	...	...	*	
Trigonocœlia (Limopsis) auritoides, *Nyst.*	...	...	*		
Stalagmium Nystii, *Gal.*	...	...	*		
Pectunculus granulatoides, Gal.					
Arca barbatula, *Lamk.*	...	...	...	*	B. Br.
Modiola?	...	...	*		
Pinna margaritacea, *Lamk.*	...	...	*	*?	B. Br.
P. affinis?, Sow.					
Pecten corneus, *Sow.*	*	...	*	*?	B. Br. L.
—— plebeius, *Lamk.*	*	...	*	*	Calc. gr.
—— imbricatus, *Desh.*	*	...	*	...	Calc. gr.
—— sublævigatus, *Nyst*	...	...	*		
—— scabriusculus?, *Mat.*	*				
—— reconditus, *Brander*	*	...	...	...	B.
Spondylus, sp. non det.	...	...	...	*	
Anomia lævigata, *Sow.*	*	...	*	*	B. Br. L.
Ostrea virgata, *Goldf.*	*	*	...	*	B. Br. L.
—— flabellula, *Lamk.*	*	*	*	*	B. Br. L.
O. Cymbula, Lamk.					
—— inflata, *Nyst*	*	...	*?	*	
—— cariosa, *Desh.*	...	...	...	*	Calc. gr.
—— gigantea, *Brander*	...	...	*	...	B.
—— gryphina, *Desh.*	...	...	*	...	Sab. m.
Dentalium substriatum, *Desh.*	...	...	*	...	Calc. gr.
—— incrassatum, *Sow.*	*	*		*	Calc. gr.
D. Deshayesianum, Gal.					
D. strangulatum, Desh.					
Calyptræa trochiformis, *Lamk.*	...	...	...	*	B. Br. L.
Vermetus bognorensis?, *Sow.*	...	*	...	...	L.?
Bifrontia serrata, *Desh.*	...	*	...	...	Calc. gr.

TABLE XIII. (continued).

	Cassel.		Brussels.		Other localities.
	Upper.	Lower.	Upper.	Lower.	
Bifrontia marginata, *Desh.*	...	...	*	...	Calc. gr.
Solarium (Vermetus) Nystii, *Gal.*	*	...	*		
—— trochiforme, *Desh.*	...	...	*	*	Br.
—— grande, *Nyst*	...	...	...	*	
—— patulum, *Lamk.*	...	...	...	*	B.
Phorus parisiensis?, *D'Orb.*	...	*	...	...	Calc. gr.
—— umbilicaris, *Brander*	...	...	...	*	B. Br.
Scalaria spirata, *Gal.*	...	...	*	...	Br.
—— subcylindrica, *Nyst*	...	...	*		
—— ——, var.?	...	...	...	*	
——, sp. nov.	...	...	*		
Turritella edita, *Sow.*	*	...	...	...	B.
—— imbricataria, *Lamk.*	*	*	...	...	B.
—— brevis, *Sow.*	...	...	*	...	B.
T. granulosa, Gal.					
—— terebellata, *Lamk.*	...	...	...	*	Br.
Melania marginata, *Lamk.*	...	*	...	...	Calc. gr.
Tornatella, sp. non det.	...	...	...	*	
——, nov. sp.	...	...	*		
Stomatia, sp. non det.	...	*			
Natica spirata, *Desh.*	...	...	...	*	Calc. gr.
—— patula, *Desh.*	*	*	...	*	B. Br.
—— sigaretina, *Lamk.*	*	...	...	*	B.
—— epiglottina, *Lamk.*	...	...	...	*	Calc. gr.
—— labellata, *Lamk.*	...	...	...	*	B. Br. Cal. gr.
—— glaucinoides, *Desh.*	...	...	*	...	B. Br. L.
—— ambulacrum, *Sow.*	*	...	...	...	B.
Globulus, Sow.					
—— parisiensis, *D'Orb.*	...	*	...	...	Calc. gr.
Sigaretus canaliculatus, *Sow.*	...	*	...	*	B. Br.
Bulla lignaria, *Linn.*	...	...	*	...	B.
—— expansa, *Dixon*	...	...	*	...	Br.
—— Bruguierei, *Desh.*	...	...	*	...	Calc. gr.
——, sp. non det.	...	...	...	*	
——, ——	...	...	...	*	
Bullæa, sp. nov.	...	...	*		
Fusus ficulneus, *Lamk.*	...	...	...	*	B. Br.
—— bulbiformis, *Lamk.*	...	*	...	*	B. Br. L.
—— errans, *Sow.*	...	...	...	*	B. Br.
—— aciculatus?, *Lamk.*	...	...	*	...	B. Br. L.
Murex porrectus, Brander.					
—— elongatus, *Nyst*	...	...	...	*	
—— longævus, *Brander*	...	...	*	...	B. Br.
F. scalaris, Lamk.					
Pleurotoma, sp. non det.	...	*			
——?	...	...	*	*	
Cerithium giganteum, *Lamk.*	*	...	*?	...	Br.
——, allied to *C. reticulatum*, Risso					
——?	...	...	...	*	
Murex tricarinatus, *Lamk.*	...	...	...	*	B. Br.

TABLE XIII. (continued).

	Cassel.		Brussels.		Other localities.
	Upper.	Lower.	Upper.	Lower.	
Cassidaria carinata, *Lamk.*	*	...	...	*	B. Br. L.
—— nodosa, *Nyst*	*	...	...	*	B.
Buccinum nodosum, Brander.					
——, sp. nov.	...	...	...	*	
Rostellaria macroptera, *Lamk.*	...	*	...	*	B. Br. L.
—— fissurella, *Lamk.*	...	*	...	*	B. Br.
Pyrula, sp. non det.	...	...	...	*	
Buccinum stromboides, *Herm.*	...	*	...	*	Br.
—— junceum, *Sow.*	*	...	...	...	B.
Conus deperditus?, *Brug.*	...	*	...	*	Br.
—— antediluvianus?, *Brug.*	*	...	...	...	Calc. gr.
—— turritus, *Lamk.*	...	...	...	*	Calc. gr.
Ancillaria	...	...	...	*	
Voluta cithara, *Lamk.*	...	...	...	*	Br.
Oliva, sp. non det.	...	...	...	*	
Terebellum, sp. non det.	...	*			
—— convolutum, *Lamk.*	...	*	...	...	B.
Seraphs convolutus, Montf.					
Nautilus Burtini, *Gal.*	*	...	...	*	L.?
N. regalis?, Sow.					
Sepia Cuvieri, *Desh.*	...	...	*	*	Calc. gr.
Beloptera?	...	...	*	*	
Serpula, sp. nov., allied to *S. triquetra*, Lamk.	...	...	*		
Cancer Burtini, *Gal.*	...	...	...	*	
——, sp. non det.	*				
Cœlorhynchus rectus, *Agas.*	...	...	...	*	
Œtobates, sp. non det.	...	...	...	*	
Pristis (Dixon, pl. 10. fig. 36.)	...	...	...	*	Br.
—— Lathami, *Gal.*					
——, nov. sp.					
Myliobates striatus, *Ag.* (Dixon, pl. 12. fig. 2.)	...	...	...	*	Br.
—— Dixoni, *Ag.* (Dixon, pl. 10. fig. 2 & pl. 12. fig. 3)	...	...	...	*	Br.
——	...	...	...	*	
Lamna	*				
—— elegans, *Agas.*	...	*	...	*	L.
Otodus obliquus?, *Agas.*	...	...	...	*	L.
—— macrotus, *Agas.*	...	*	...	...	L.
Edaphodon Bucklandi, *Ag.* (Dixon, pl. 10. fig. 21)	...	...	...	*	Br.
Zeus armatus, *Blainv.*	...	...	...	*	
Pleuronectes maximus, *Blainv.*	...	...	...	*	
Ear-bone of Fish?	...	...	...	*	
Emys Cuvieri?, *Gal.*	...	...	...	*	
Gavialis Dixoni, *Owen* (Dixon, pl. 12. fig. 4)	...	...	...	*	Br.

The results of most value deducible from the above Table are those suggested by the fossil Mollusca. The total number of these enumerated is 157, but some of them can only be determined generically from casts, and others are new and as yet undescribed. The number of named species is 122, and no less than 106 of these are common to the Eocene beds of England and France; 102 being of the age of the Barton and Bracklesham beds of England or the corresponding *Calcaire grossier* of France, while only four belong exclusively to the London Clay proper or to the *Sables inférieurs* of France. The identity, therefore, of this portion of the Cassel and Brussels tertiary series with the British Middle Eocene group is very striking. In regard to the unnamed fossils, some of them are probably peculiar to French Flanders and Belgium, but most of them might be identified with British species, if we had the means of comparing them in London with large numbers of English Eocene fossils still undescribed.

The next result worthy of notice is derived from the "Upper Brussels" column relating to the shells, obtained, chiefly by the exertions of Capt. Le Hon, from Laeken, Jette, and other localities of the same "Upper Nummulitic" strata near Brussels. These species, belonging to what has been termed by M. Dumont the *Système Laekenien*, are sixty-five in number, eighteen of which are at present peculiar, but I have no doubt that this proportion might easily be reduced, inasmuch as the researches of the late Mr. Dixon in the Eocene deposit of Bracklesham, near Chichester, have brought to light many Mollusca and Bryozoa identical with Laeken fossils. Out of fifty-seven named Laeken shells, no less than forty-four are common to the *Calcaire grossier*, or beds of the same age in England. Such being the case, we have no reason to feel surprised that the fossils of the ferruginous sands of Mont Noir, near Cassel, which overlie strata corresponding in age to the Laeken beds of Brussels, should nevertheless contain shells which agree with the Bagshot and Bracklesham fauna of England. In other words, the *Système Laekenien* is simply one of several upper divisions of the *Calcaire grossier*.

It may, at first sight, seem strange that there are not more species common to the Cassel and Brussels lists, only thirty-two named species being common out of a total of 122; also that in each district so few species are common to the upper and lower divisions, at Cassel only sixteen out of sixty-two named species being common to the upper and lower series, and at Brussels only fifteen out of ninety-two species. How are we to reconcile such a result with the fact that each of these sets of fossils, when compared to the *Calcaire grossier* or Middle Eocene of England and France, exhibits nearly an equal amount of identity? The apparent inconsistency is, I think, removed when we recollect that each of the asterisk columns of Table XIII. represents a mere fraction of a great fauna obtained from the Middle Eocene beds of the south-east of England or from the Paris Basin. The analogous degree of relationship of the Cassel and Brussels fauna to one and the same foreign equivalent shows that they would

each approximate much nearer to each other, if we were able to extend our knowledge of the fossils of the respective districts; although there would still remain some distinctions arising from variations of species in space or in time; the representation of each precise stage, or division in time, of the fossils of the same Middle Eocene group being always imperfect, and usually unequally so in the several countries compared. The small number common to the "upper and lower Brussels" beds, or to the upper and lower Cassel beds, *i. e.* to the Upper and Middle Nummulitic, is no doubt in part the effect of change of species in time, and corresponds to the distinction between the Barton beds and the lower Bagshot (or lower Bracklesham) in England, or that of the *Sables moyens* (*grès de Beauchamp*) and the *Glauconie grossière* in France.

The number of Plants, Zoophytes, and Vertebrata common to the different divisions, or to the two districts, is too small to require me to dwell upon them. So far as they go, they coincide in their bearing with the conclusions to which we are led by the fossil Mollusca.

[2.] *Middle Eocene strata near Mons. Mont Panisel.*

It is well known that in the neighbourhood of Mons (about thirty-five English miles S.S.W. of Brussels) the Maestricht chalk is seen at Ciply, and above it are sands and clays (at Chasse Royale and other places), referred to the *Système Landenien* of Dumont. At a higher level, strata containing *Nummulites planulatus* in abundance have been found in wells sunk in the city of Mons. I found the same Nummulite in Mont Panisel, in the suburbs, sparingly dispersed through beds of clay and in greenish and yellowish ferruginous sands in which were some cherty beds containing casts of fossils with silicified shells. I examined Mont Panisel in company with M. A. Houilliez and M. Ch. De Beaulieu, and with their assistance obtained the following fossils:—

Nummulites planulatus.	Tellina.
Pinna margaritacea; abundant.	Nucula.
Loripes divaricata,	Crassatella.
Cardium porulosum?	Astarte.
Cassidaria nodosa.	Cardita.
Natica patula?	Fusus.
Lucina gibbosa.	Voluta.
Solen.	

These seem to be inferior to the Brussels Beds, of which the fossils are enumerated in the "Lower Brussels" column of Table XIII.

[3.] *Renaix, Craye, and Audenaerde.*

From the hills of Renaix, Mont Panisel above-mentioned may be seen. Near Renaix, about two miles S.E. of the town (see Map, Pl. XVII.), the stony beds with *Nummulites planulatus* are exposed to view in the bed of a small brook, where they are associated with clays and sands. The locality alluded to occurs in the Commune of St. Sauveur, on the farms of Tombelles and Arabie, where I was

conducted to a fine section by M. E. Joly, Advocate, well known for his antiquarian researches. Beds of clay, alternating with greenish sands and brick-earth, cover the solid layers of Nummulite-limestone to a thickness of 100 feet, and among them occur indurated siliceous sandstones similar to those in Mont Panisel, before-mentioned, with chalcedonic casts of shells, *Pinna margaritacea* being very abundant. The following fossils, collected by myself, or given me by M. Joly, are from this place or from Ellezelles near Renaix :—

Turbinolia sulcata, *Lamk.*
Solen.
Corbula, cast.
Tellina donacialis ?, *Edwards.*
Tellina.
Cytherea, near *C. obliqua*, Desh.
——, near *C. nitidula* ?, Lamk.
Cardita planicostata, *Lamk.*
Nucula margaritacea, *Lamk.*
Pinna margaritacea, *Lamk.*
Pecten.
Ostrea flabellula, *Lamk.*
Turritella imbricataria, *Lamk.*
Natica, allied to *N. Hantoniensis*, Sow.
Natica.
Fusus longævus, *Lamk.*
Pleurotoma.
Rostellaria fissurella, *Lamk.*
Cassidaria carinata, *Lamk.*
Voluta luctator ?, *Sow.*
——, two other species.
Terebellum.
Cypræa.
Nautilus, cast.
Cancer Leachii ?, *Desm.*
Xanthopsis, M'Coy.

At Kraye (or Craye), to the N.W. of Renaix, on a road leading from Renaix to Berchem on the Scheldt, I found sands with dispersed specimens of a variety of *Nummulites planulatus*, about 150 feet higher in the series than the solid beds at the farm of Arabie before-mentioned. These upper grey sands with green grains contain in great abundance an orbicular variety of *Cardita planicostata*, with *Cardium porulosum*, *Corbula*, &c.

At Audenaerde I observed beds similar to those of Renaix and Mont Panisel, the *Pinna margaritacea* being abundant in cherty beds which are sometimes used for pavement.

[4.] *Courtray.*

Three miles south of Courtray I found a tertiary clay, extensively worked for brick-making, which abounded in *Nummulites planulatus* in a very perfect state of preservation. I was directed to this region as likely to afford fossil remains by M. Dumont. The clay of Courtray evidently belongs to the Lower Nummulitic division, E. 3 of Table I. p. 279.

The fossils which accompanied the Nummulites, including a *Turritella* and some others, were too imperfect to admit of being specifically determined.

[5.] *Ghent.*

About three miles south of Ghent, at the country-house of M. F. Loozberg, an artesian well had been sunk to the depth of 70 metres at the time of my visit. The upper 35 metres consisted of sandy and clayey glauconites, with *Nummulites planulatus* dispersed through them at several levels. In examining this Glauconite Mr. Rupert Jones has lately found a few specimens of two species of Entomostraca, viz. *Cythere angulatopora*, Bosq., and *Cytherella Munsteri*,

Rœm. sp., both which (according to M. Bosquet*) occur in the Eocene strata of France. The lower half was made up of stiffer clay of a bright green colour, and lower down of darker colour, in which I found no Nummulites. As the Brussels beds with *Nautilus Burtini* occur in the trenches of the citadel at Ghent, I imagine the green sands of this well to belong to E. 3 of Table I., or the *Système Ypresien* of M. Dumont. It may perhaps be found possible and convenient to draw here and elsewhere a line of demarcation between the Ypres beds and the London Clay proper at the point where the Nummulites cease. Whether the beds containing *N. planulatus* near Ghent or Courtray may correspond in age with an upper division of the London Clay proper, or with the lowest part of the Bagshot series, cannot as yet be decided.

[6.] *Mons-en-Pevelle, near Lille.*

At no locality visited by me were the bands of Nummulitic limestone so conspicuous as at Mons-en-Pevelle, about nine miles south of Lille, to which my attention was directed by M. Meugy. The thickness of the formation (overlying the London Clay) to which they belong is estimated by that geologist at about 100 feet. I saw the layers of nummulitic rock, from 6 to 8 inches thick, extending throughout a thickness of about 60 feet of sandy and clayey beds. Not only were the roads made of them, but several buildings were in part constructed of the same, and I saw the yard of a farm-house paved with nummulitic slabs. With the exception of a *Dentalium* (*D. Deshayesianum*), I could find no fossils in the associated strata. In this part of French Flanders the lower nummulitic beds are separated from the Chalk by about 150 feet of London Clay, and nearly 100 more of Plastic clay and sand.

§ 8. *London Clay proper* (F. 1. Table I.). *Argile Ypresien, étage inférieur*, Dumont.

I have already stated, p. 331, that at the railway-station at Cassel a mass of brown clay with septaria was bored to the depth of 100 metres, and the bottom not reached. In uniformity of aspect it resembled the clay of Highgate and other places near London, and the absence of shells in the large heaps of clay extracted from the well, which I examined carefully, might be paralleled by a similar dearth of fossils in numerous sections in the London and Hampshire basins. The green sands and clays above the London Clay in the Hill of Cassel much resemble those containing *Nummulites planulatus* elsewhere, although I could not meet with that fossil at Cassel.

Near Lille a mass of clay, estimated by M. Meugy to be about 44 metres (or 145 feet) thick, underlies the *Nummulites planulatus* sands and limestone of Mons-en-Pevelle already described, and under that again are sands and clays, probably corresponding to the Plastic

* Descript. des Entom. Foss. des Terrains Tertiaires de la France et de la Belgique, Mém. Couron. Acad. Roy. Belg. vol. xxiv.

clay and sand near London. No progress seems yet to have been made here or elsewhere in obtaining fossils from the *argile Ypresien*, whether in French Flanders or Belgium. In the latter country this clay appears to be feebly developed, or usually wanting, as in the Paris basin.

At Bailleul, between Cassel and Lille (see Map, Pl. XVII.), many shells were met with in boring a well through this clay, but they were not preserved.

At Brussels, a mass of clay, lying over the Chalk and about 80 feet thick, was found in boring wells. It is separated from the chalk, as before stated (p. 350), by a band of flint-pebbles coated with green earth. There are not sufficient data as yet for deciding whether part of this clay should be referred to the London Clay proper.

§ 9. *Plastic Clay, Sand, and Lignite* (F. 2. Table I. p. 279). *Système Landenien supérieur*, Dumont. *Lower London Tertiaries*, Prestwich.

1. *Carvin, near Lille.*

Below the London Clay near Lille are sands and clays, about 80 feet thick, which resemble the beds near London usually called "Plastic clay and sand." The only fossils as yet found in them are marine, and occur in a clay, not more than 25 or 30 feet above the chalk. M. Meugy took me to the junction of the chalk and tertiary strata at Carvin, twelve miles south of Lille (see Map, Pl. XVII.). Within 300 yards of the church of Carvin we saw an open well just dug, where the White Chalk with flints appeared within 10 feet of the surface. Upon it there was no parting band of pebbles, but, in contact, schistose sandy clay, greenish but not glauconiferous, with a few well-rolled black pebbles interspersed. This clay or loam was 10 feet thick. At a short distance, and no doubt incumbent on the above, a tenacious clay occurs, several feet thick, which is worked for pottery; and above this again, in another pit, the sandy clay with concretions in which shells abound. Among these the *Cyprina Morrisii*, Sowerby ('Min. Con.' vol. vii. p. 20, pl. 620), abounds, which is characteristic of the Plastic Clay near London, and a *Turritella*, *Arca*, and *Corbula*, in casts too imperfect to admit of being specifically determined. There are white sands with some solid beds of sandstone in them near Lille, between the clay with *Cyprina Morrisii*, above-mentioned, and the London Clay, but I saw no good sections.

2. *Jauche, Huppaye, Oplinter, &c.*

In Belgium, above the "Lower Landenian," which I shall presently describe, and below the Brussels beds with *Nummulites planulatus*, there occurs a formation of sand, siliceous paving-stone, and lignite, to which the name of *Landenien supérieur* has been given by M. Dumont. As no fossil shells have been found in it, I cannot identify it palæontologically with that part of the British Tertiaries with which it may probably be contemporaneous. I saw its super-

position to the Lower Landenian near Jauche, on the road leading to Enines (Map, fig. 2, Pl. XVII.), where it is 40 feet thick, and consists of alternating yellow and whitish sands, resembling the "striped sands" of Lewisham and Woolwich, and, like the British "Lower Tertiaries," containing a bed of lignite. At a higher level in the series, at Huppaye, in the same district, this formation contains snow-white sands with beds of hard paving-stone or siliceous sandstone, from 7 to 10 feet thick. I saw the same "striped sands" at Marilles, about one league north-east of Huppaye, traversed by a layer of well-rounded flint-pebbles. In the neighbourhood of Tirlemont I found fragments of silicified wood in this part of the series, and at Oplinter, a few miles north of Tirlemont, clay with lignite and the leaves of dicotyledonous trees. To this locality I was conducted by M. de Koninck. M. Dumont informed me that, at some points, the alternations of clay and beds of lignite in the middle portion of this series are very numerous. We may hope, therefore, that some fossil plants, at least, may hereafter be obtained.

Near the railway station at Landen I saw a section of the upper Landenian formation, consisting of white and yellow striped sands without fossils, about 35 feet thick.

§ 10. *Glauconite of Tournay and Angres* (G. Table I. p. 279). *Beds between the Plastic Clay and the Chalk of Maestricht. Système Landenien inférieur*, Dumont.

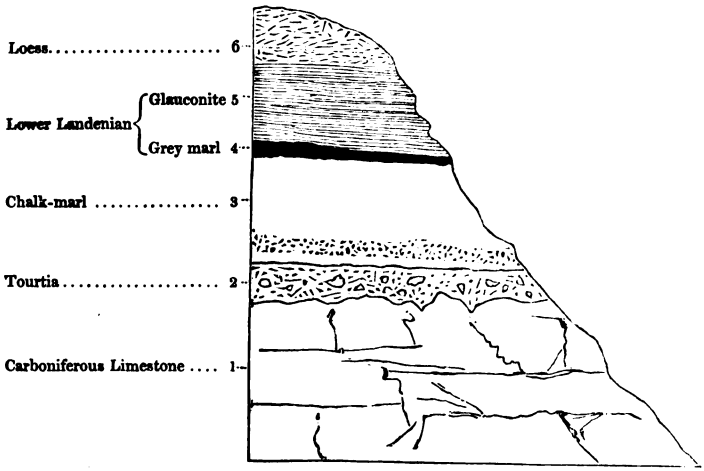
I have next to describe strata which are certainly older than those last alluded to, but concerning the relations of which to the Tertiary or the Cretaceous series, much difference of opinion exists. The localities where I examined this series, called "Lower Landenian" by M. Dumont, were:—1. Tournay. 2. Angres, near Quiévrain, about fourteen miles S.W. of Mons: see Map, fig. 1, Pl. XVII. 3. In the province of Hesbaye, at Folx-les-Caves, Orp-le-Grand, Lincent, and several other places.

1. *Tournay.*

About two miles from the Valenciennes gate of Tournay, on the left bank of the Scheldt, are some large quarries deeply excavated in the Mountain or Carboniferous limestone. In one belonging to M. Dapsens Carbonnel, the limestone (1) is seen covered as in the accompanying section, fig. 10, with a well-known member of the chalk, provincially called "tourtia" (2), above which is white chalk-marl (3), with the usual fossils, upon which rest strata (4, 5), referred by M. Dumont and others to the tertiary series, and called in Belgium "Lower Landenian." The lowest of these is an argillaceous grey marl (4), strongly contrasted in its darker colour with the white chalk-marl. I found in this grey marl (4) a perfect specimen of a well-known chalk fossil, *Terebratula gracilis*, Schlotheim (*T. rigida*, Sow., 'Min. Conch.' vol. vi. p. 69, pl. 536. fig. 2), with both valves united. With this was *Terebratula striatula*, in abundance, also *Ostrea* (*Exogyra*) *lateralis*, Nyst, and a *Bryozoon*.

Reposing on the marl (4) and passing into it at the junction are

Fig. 10.—*Section near Tournay.*



beds of a green sandy glauconite (5) 10 feet thick, in the upper part of which layers of cherty stone from 6 to 8 inches thick abound, with casts of shells. In this glauconite the same *Ostrea lateralis* and *Terebratula striatula* occur which are met with in the grey marl (4), so that it seemed to me impossible to draw a line between the beds "4" and "5," or to consider "4" as cretaceous and "5" tertiary. The other fossils which I found in "5" consisted of a *Pholadomya* (*P. Koninckii*?), *Cucullæa*, *Pinna*, *Turritella*, *Fusus*, *Natica*, &c., chiefly casts, and these in too unsatisfactory a state to admit of being specifically distinguished. A gigantic *Pleurotomaria*, sometimes retaining its shell, is not uncommon in these beds, and is very unlike any fossil occurring in the Lower Tertiaries of England or France. It resembles rather the *P. gigantea* of the Lower Greensand. One species, and as yet one only, of this genus, is known in the *Calcaire grossier*,—*P. concava* of Deshayes ('Coq. Foss. de Paris,' vol. ii. pl. 32. fig. 1, 2, 3), much smaller in size, though somewhat analogous in form. According to Baron Ryckholt, who possesses the finest collection of shells from the glauconite of Tournay, all the species which have been referred to tertiary shells are distinct. Not a few of them he considers identical with fossils of the Faxoe, Maestricht, and other cretaceous formations. The difficulty of defining the specific characters in the genera *Pholadomya*, *Scalaria*, *Mya*, and *Pinna*, without having a full and perfect series of the individuals for comparison, is such that I cannnot pretend, without better specimens than I brought from Tournay and Angres, to offer a positive opinion on this point. I believe nevertheless that Baron Ryckholt, when he publishes a full account of his valuable collection, will succeed in proving the beds in question to be older than any fossiliferous strata above the Chalk in England.

2. *Angres, near Quiévrain.*

At Angres, near the southern frontiers of Belgium, fourteen English miles south-west of Mons, the White Chalk with flints is covered with a solid glauconite, free from calcareous matter, and full of the casts of shells. I visited this place in company with M. de Beaulieu, Professor of the École des Mines at Mons. We found a section in a hollow way, within half a mile N.N.E. of the church of Angres, where a thickness of 25 feet of thin-bedded and half-solidified glauconite is seen. The stone at some points becomes very hard, and the green grains are larger and more widely scattered in the upper beds. I obtained the casts of about fifteen shells, belonging to the genera

Arca.	Venus?
Cucullæa (allied to *C. decussata*).	Tellina.
Panopæa (like *P. intermedia*?).	Pinna.
Pectunculus.	Ostrea.
Crassatella.	Turritella.
Nucula.	Lucina?
Pholadomya (resembling *P. cuneata*, Sow. M. C. pl. 630).	Natica.
Astarte.	Calyptræa.

Also a Bryozoon (Retepora?) and an Echinoderm.

The casts were many of them decidedly the same as those already mentioned as occurring near Tournay. We afterwards saw a similar glauconite with similar fossils at Baisieux, two miles north of Angres, and about a mile south of Quiévrain.

The matrix of the shells at Angres is sometimes quite undistinguishable from that Middle Eocene glauconite, with large coarse grains of green earth, which occurs at Boeschepe near Cassel, before described, p. 325, and in which casts of a large *Ovula* and other shells occur. It is one of many instances in Belgium of the identity in mineral character of tertiary beds of very different ages, to which the abundance of glauconite particularly contributes.

3. *Folx-les-Caves, Jauche, Jendrain, Orp-le-grand, &c.*

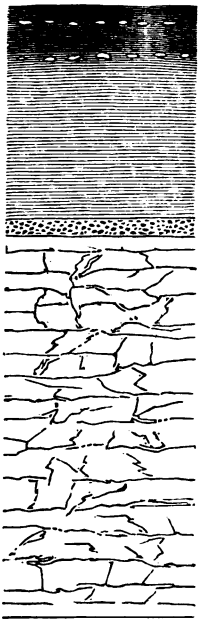
I shall now pass to another part of Belgium (between Brussels and Liege, seventy or eighty miles eastward of Tournay), where strata, also called "Lower Landenian," and probably of about the same age as those of Tournay and Angres already described, are met with in the cantons of Landen, Jodoigne, and Tirlemont. See Map, fig. 2, Pl. XVII.

At Folx-les-Caves, the most southern point where I saw this formation, it rests on the Maestricht Chalk, fig. 11, I, which is there quarried to the depth of 20 feet for building-stone, and exhibits *Belemnites mucronatus* and other characteristic fossils.

The chalk is covered by a bed of rolled flint-pebbles, some of which are 4 inches in their longest diameter. This bed (G. 2), forming the base of the "Lower Landenian," is 1 foot thick, and supports a stratum (G. 1) of soft glauconite, 6 feet thick, the upper part of which is clayey, and contains some small dark concretions, which, like the greensand matrix, are highly calcareous. The fossils in the

glauconite (G. 1) consist chiefly of *Astarte inæquilateralis*, Nyst, well-preserved and often with both valves united. On one of these I found a small attached coral (*Dendrophyllia*). In the same bed a large species of *Dentalium* occurs, and some casts of Bivalves.

Fig. 11.—*Section at Folx-les-Caves.*



	ft.
G 1. Glauconite; upper part clayey, with small concretions	6
G 2. Pebble-bed	1
I. Maestricht Chalk	20 exposed.

No other member of the "Lower Landenian" is seen at Folx-les-Caves, but a solid and whitish glauconite, called by Omalius d'Halloy *tufeau de Lincent*, occupying a higher position in the same series, is met with at the distance of three or four miles to the north and west, as at the village of Jauche, where there is a hollow lane in which the whitish tufeau and greenish sand or soft glauconite are seen to attain a thickness of about 20 feet, and greatly to resemble in character some members of the Chalk and Upper Greensand of many parts of Europe. The tufeau is highly calcareous and of small specific gravity, hence it is of cheap carriage and highly useful as a building-stone. Some of the beds are cherty; casts of a small *Nucula* (*Leda*) are most common in the tufeau. In part of the region alluded to, the Lower Landenian rests immediately on White Chalk with flints without the intervention of the Maestricht chalk, as at Jandrain, and sometimes, as in the immediate neighbourhood of that village and on the road from it to Orp-le-Grand, the Maestricht chalk is reduced to a thickness of less than 2 feet between the White Chalk with flints and the overlying Landenian. The Maestricht bed here contains large concretions of silex, more or less pure, and is full of

Thecidea radians and *Belemnites mucronatus*, with *Terebratulæ* and other characteristic fossils; it contains also many rolled pebbles of flint near its junction with the White Chalk. This fact is important, as showing that the White Chalk with flints had suffered denudation previously to the deposition of the Maestricht beds. The occurrence of rolled pebbles at the base of the Maestricht rock is analogous to the pebbly glauconite which separates the Maestricht chalk from the Lower Landenian, so that the parting layer of pebbles, which at Folx-les-Caves might seem, at first sight, to afford good ground for separating the cretaceous and tertiary formations, loses all importance as a line of demarcation. The upheaval and exposure of the secondary rocks had evidently begun before the termination of the cretaceous period.

In the middle of the village of Jendrain above mentioned a chalk-pit has been opened, where the White Chalk with flints is covered immediately by the Lower Landenian containing the wreck of the Maestricht chalk, and its flints or cherty rock, which consist of huge flattened masses, several feet in diameter. At Wanzin (Map, fig. 2. Pl. XVII.), I saw several sections where the surface of the White Chalk had been much denuded, and where the whitish glauconite or tufeau of the Lower Landenian, characterized by *Astarte inæquilatera*, filled up inequalities scooped out of the older rock.

4. *Orp-le-Grand, Pellaines, Lincent, and Amptieau.*

At Orp-le-Grand the light tufeau is quarried for building purposes to a depth of more than 20 feet. One of the most conspicuous fossils, called *Gyrolites* (*Vermiculites* of Nyst), resembles the tubular cavities left by a large boring Annelid, and traverses the stone in curves several inches in diameter. The *Astarte inæquilatera* connects this rock with the glauconite before mentioned of Folx-les-Caves. The *Pholadomya Koninckii*, also abundant, forms a link between it and the glauconite of Tournay, before mentioned, p. 362. With these shells I found a cast and impression of a large *Scalaria*, which appears undistinguishable, so far as a cast will admit of comparison, with a species in Mr. Bowerbank's cabinet from the Lower London Tertiaries or Thanet Sands. The other shells are *Dentalium*, casts of *Cucullæa*, *Arca*, *Nucula*, *Turritella*, *Natica*, and *Pleurotoma*?, with teeth of *Lamna*. I found also two species of Echinoderms, one of them, according to Professor E. Forbes, of the genus *Hemiaster*, a form belonging equally to the cretaceous and tertiary periods; and the other referred to *Cardiaster* by the same authority, who remarks that this genus has hitherto been only met with in *cretaceous* strata. This discovery is interesting in its bearing on the question whether the Lower Landenian fauna has most relationship with a cretaceous or a tertiary type, or whether it be not intermediate in character and in age. No Baculite, Belemnite, Ammonite, or other Cephalopod of a family peculiar to the Chalk, has hitherto been met with in these beds; but the same may be said of the true cretaceous strata in many regions.

I visited Pellaines and Lincent, where magnificent square blocks

and tall columns of the tufaceous building-stone are obtained from the quarries, and the same fossils as at Orp-le-Grand. At Amptieau I found the Lower Landenian passing into a white calcareo-argillaceous rock, much used as a fire-stone, in which I observed *Pholadomya Koninckii* and a small *Leda*, allied to *L. fragilis*. As usual in Belgium, a deep covering of loess renders it difficult to obtain sections.

It may be proper to mention here, that many decidedly Eocene shells have been cited from Orp-le-Grand and the other localities just alluded to, chiefly on the authority of M. Galeotti; but having failed to detect any of them *in situ* here or elsewhere in beds of this age, and having conversed with M. Galeotti himself, I am convinced that they were introduced into the published lists by mistake. These shells have not only been cited from M. Galeotti's memoir by M. Nyst and M. d'Omalius d'Halloy*, but more recently by M. d'Archiac†. Among these spurious fossils are *Nummulites lævigatus, Lunulites radiatus, Turbinolia sulcata, Cytherea nitidula, Lucina divaricata, Cardium porulosum, Cardita elegans, Ostrea flabellula, Dentalium Deshayesianum, Melania marginata, Cassidaria carinata, Solarium Nystii,* and other Eocene shells, not one of which has ever been met with in the "Lower Landenian" of Dumont.

§ 11. *Marls and Glauconite of Heers* (H. Table I. p. 279). *Système Heersien* of M. Dumont.

Between the formation last mentioned and the Maestricht chalk, there intervenes another series of strata, discovered by M. Dumont, and called by him *Heersien*, from the village of Heers (six miles N.N.E. of Waremme). These are best seen near the village of Oreye, at the farm of Vivier, about six miles N.E. of Waremme, where they consist of white marl, resting on sandy glauconite, and this last on Maestricht chalk.

I had no opportunity of examining this locality, but was conducted to another by M. Dumont at Marlinne, between Waremme and Looz, about fifteen miles E. of Orp-le-Grand, and four miles N. of Waremme, where this formation consisted of a white marl, 20 feet thick, as white as chalk, but not so soft, and containing leaves of dicotyledonous plants, but no shells. It is here seen to underlie the Lower Landenian, which reposes upon it in the form of a glauconite, similar to that of Folx-les-Caves. No progress has yet been made in comparing the species of dicotyledonous leaves with those found in other formations. Their occurrence affords no evidence of the tertiary nature of the Heersian strata, now that Dr. Debey has brought to light in the lower cretaceous beds of Aix-la-Chapelle so great a variety of the leaves of dicotyledonous plants‡.

It is clear, therefore, that there are in Belgium certain deposits, consisting of glauconites and marls, interposed between the Chalk

* Géologie de la Belgique, 1842. † Hist. des Progrès, vol. ii. p. 502, 1848.
‡ Entwurf zu einer Geogn. Darstellung der Gegend von Aachen, 1849. See also Quart. Journ. Geol. Soc. vol. vii. Part II. p. 109.

of Maestricht and beds of the age of the Lower London Tertiaries. The change in Europe from the Maestricht and Faxoe fauna to that of the Lower Eocene is so vast as to prepare us for the discovery of a long series of such intermediate rocks, characterized by species in part new and in part cretaceous or tertiary,—formations in which genera, hitherto regarded, like the *Cardiaster*, as exclusively secondary, and others only known before as tertiary, may be found associated. Instead of grouping all these monuments of an intervening period as Cretaceous or as Eocene, it may be convenient to introduce a new system, to which the *calcaire pisolitique* of France and the Heersian and Lower Landenian of Belgium may be referred.

In the Synoptical Table of tertiary formations, which has been introduced into an early part of this paper (p. 279), it will be seen that, so far as I have been able to ascertain, the Lower Landenian and Heersian groups have no exact equivalents in the British Islands. This opinion may require modification hereafter, when a fuller comparison has been instituted between the Lower Tertiary fossils of England and those of Belgium. In the meantime, the place assigned by M. Dumont to the Lower Landenian will be understood by consulting his Tables already alluded to (p. 279, *note*) and printed as Appendices Nos. I. and II. One of these was published in 1851, and the other appears now for the first time, having been recently communicated by the author, after his return from a geological excursion in England in the autumn of 1851. To him, and to all the other geologists of Belgium with whom I had the pleasure of conferring, I have to express my warmest thanks for their zealous and effective cooperation. I must also avail myself of this opportunity of acknowledging my obligations to MM. Nyst and De Koninck in particular, for their unremitting attentions during my tour, and their instructive correspondence since my return. In several of the principal districts, the reader cannot fail to have perceived that I should have made but little progress in the examination of their palæontology without such assistance as that afforded me at Antwerp by M. Norbert de Wael, at Brussels by Captain Le Hon, and in the Limburg by M. Bosquet. These naturalists have enabled me to present to the scientific world a more complete catalogue of the fossils of the several regions studied by each of them, than had previously been printed; and in each case, when they generously placed at my disposal the ample materials which it had cost them the labour of years to bring together, they asked no other return for the gift than that I should obtain the opinions of the best English palæontologists on their fossils. I have accordingly endeavoured by the aid of several friends, whose names appear frequently in this memoir, especially those of Messrs. S. V. Wood, Morris, Edwards, Rupert Jones, Hooker, and E. Forbes, to discharge the debt incurred to my foreign fellow-labourers; giving the results of their comparison of Belgian and British fossils, respecting which doubt and discussion had arisen, whether in reference to specific characters, or to position in the geological series.

It may also be well to state, before concluding, that, notwithstanding the slight inequalities of level and the rarity of natural sections in a

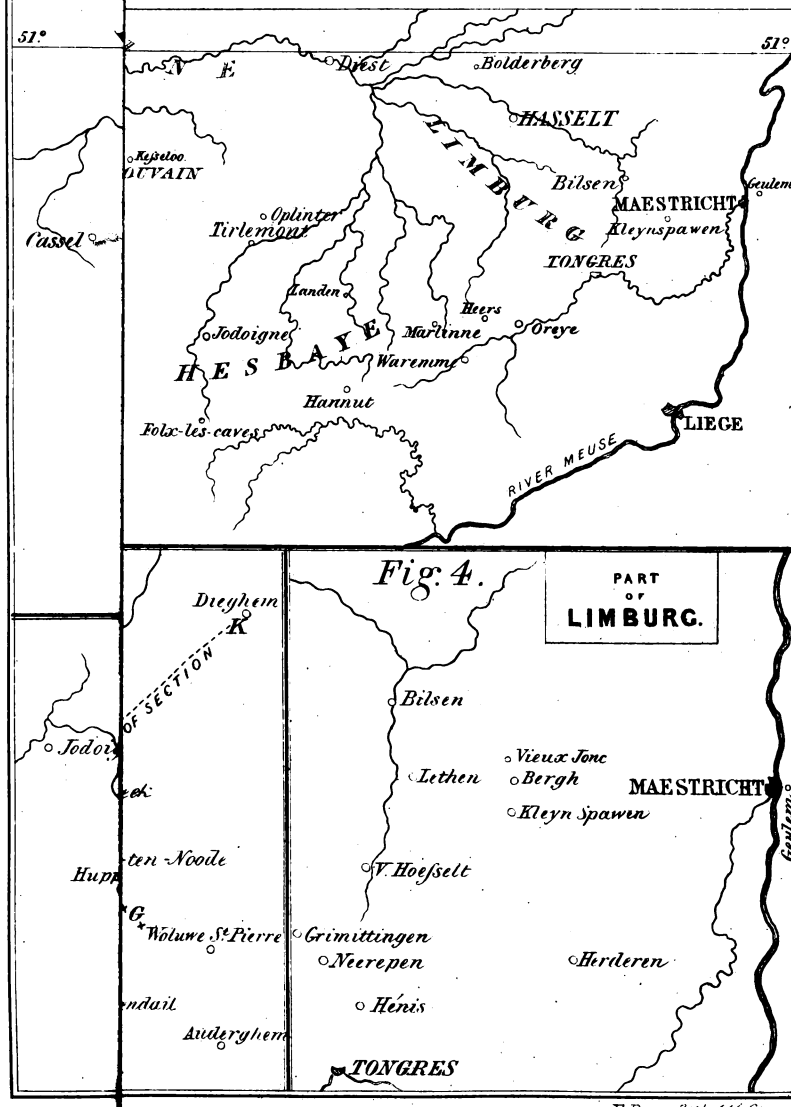
great part of Belgium, no European country of equal area affords a richer, perhaps no one so rich a field for the study of rocks newer than the White Chalk with flints. I have stated in the present memoir, that the older Pliocene or Crag strata of Suffolk are very fully represented at Antwerp, and that in the Limburg the Upper Eocene group is more completely developed than its equivalent in the Isle of Wight. The Bolderberg affords an example of beds intermediate between the two groups last mentioned (probably of the Miocene period), to which nothing similar in age has yet been found in England. Again, the chalk of Maestricht or Ciply, long recognized as an upper and peculiar member of the cretaceous system, is another rock of which we have no example in Great Britain. Last, not least, there have been discovered by M. Dumont and others, near Tournay and in different parts of Hesbaye, strata occupying a position between the Maestricht Chalk and the Lower London Tertiaries. These Lower Landenian and Heersian groups of Dumont promise no scanty harvest to the collectors of organic remains, and may, therefore, soon be made to throw light on a period of the earth's history as yet more obscure than any other of equally modern date. Judging from the character of the numerous publications which have appeared in Belgium during the last fifteen years, we may confidently affirm that the scientific explorers of that country will continue to prove themselves worthy of the grand field of investigation thus thrown open to them.

MAP

OF PARTS OF BELGIUM AND FRENCH FLANDERS

to accompany a memoir

by Sir Charles Lyell.



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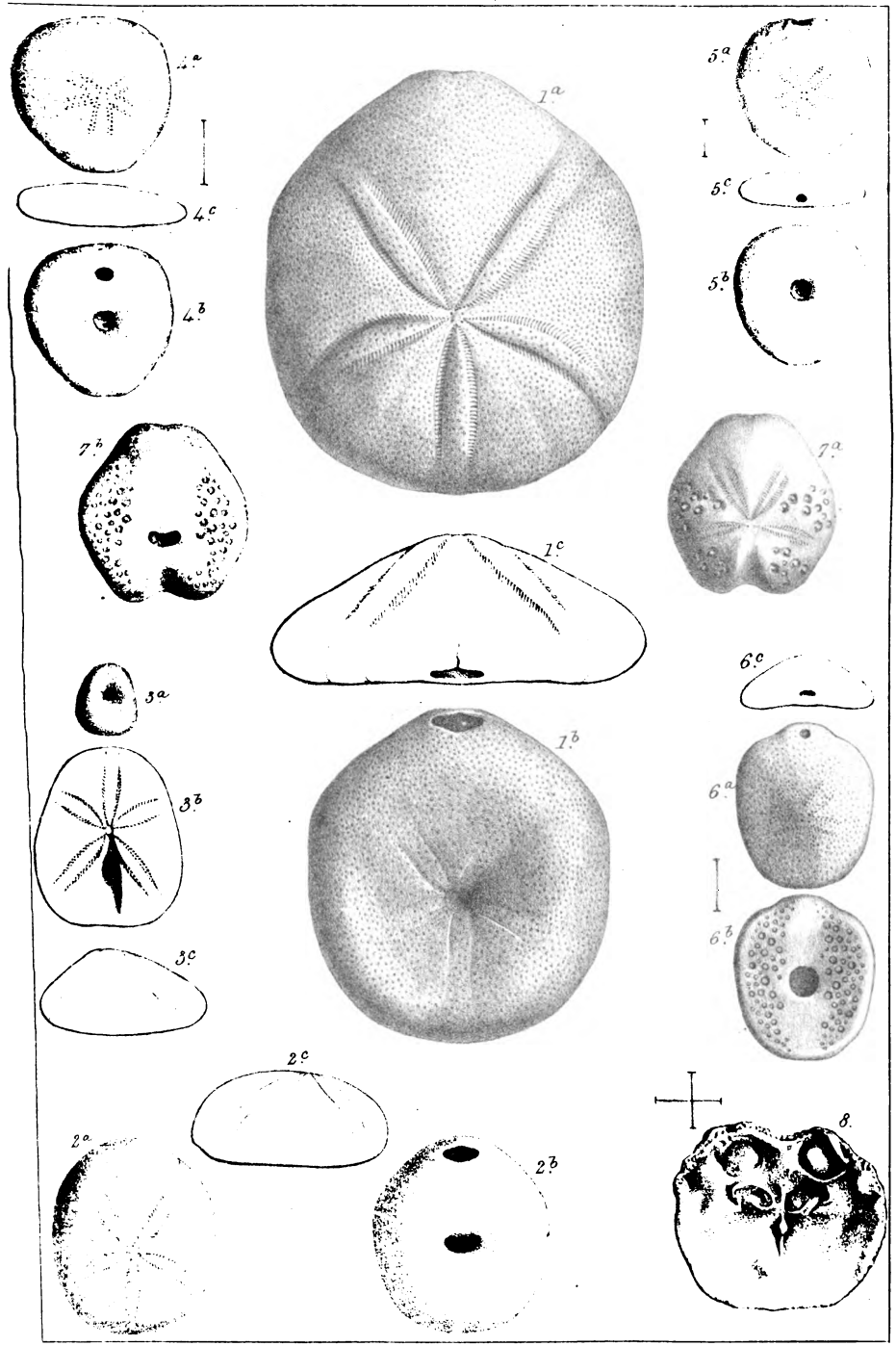

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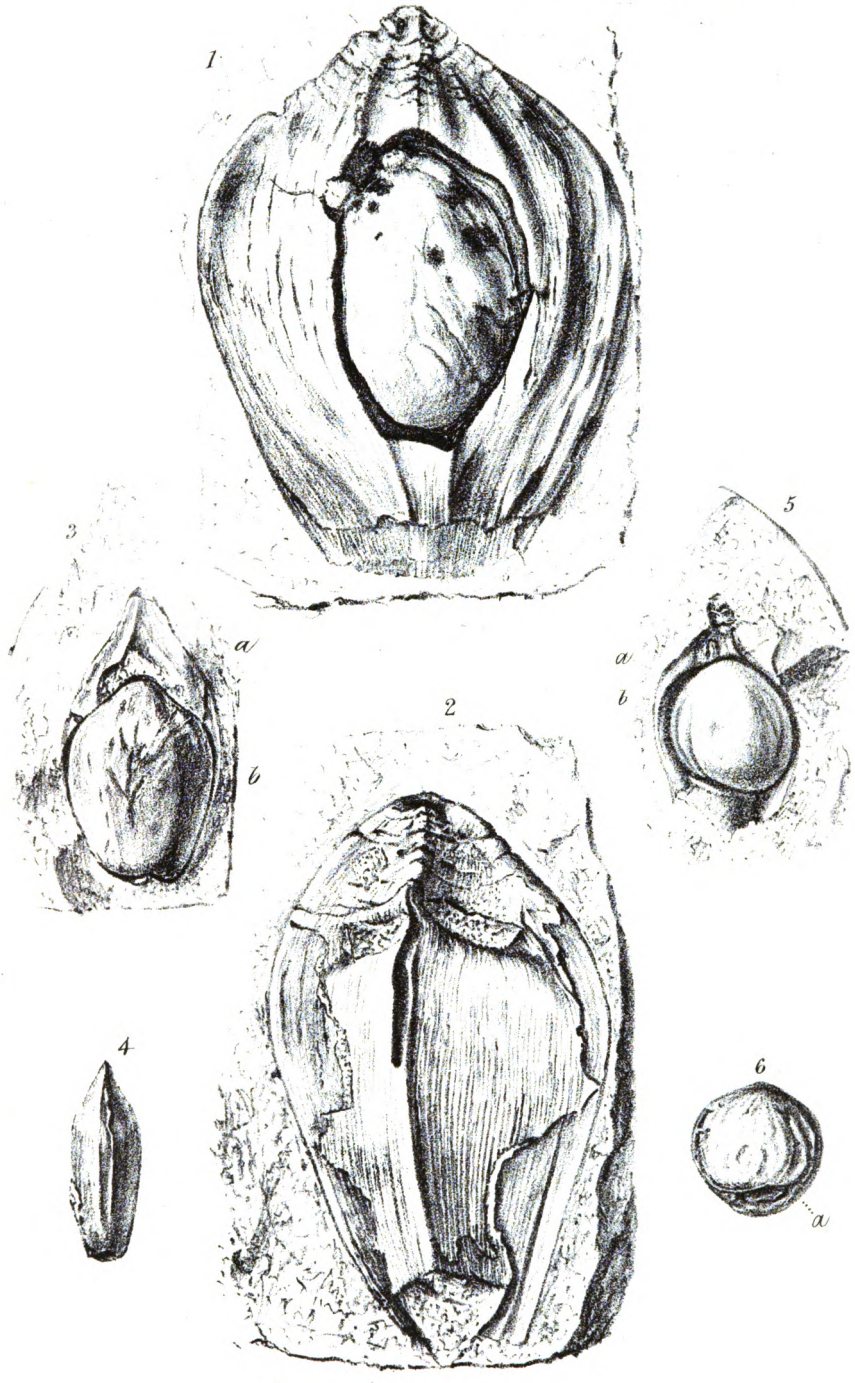
Eocene Fossils of Belgium.



Eocene Fossils of Belgium

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J. de C. Sowerby Fecit

The results of most value deducible from the above Table are those suggested by the fossil Mollusca. The total number of these enumerated is 157, but some of them can only be determined generically from casts, and others are new and as yet undescribed. The number of named species is 122, and no less than 106 of these are common to the Eocene beds of England and France; 102 being of the age of the Barton and Bracklesham beds of England or the corresponding *Calcaire grossier* of France, while only four belong exclusively to the London Clay proper or to the *Sables inférieurs* of France. The identity, therefore, of this portion of the Cassel and Brussels tertiary series with the British Middle Eocene group is very striking. In regard to the unnamed fossils, some of them are probably peculiar to French Flanders and Belgium, but most of them might be identified with British species, if we had the means of comparing them in London with large numbers of English Eocene fossils still undescribed.

The next result worthy of notice is derived from the "Upper Brussels" column relating to the shells, obtained, chiefly by the exertions of Capt. Le Hon, from Laeken, Jette, and other localities of the same "Upper Nummulitic" strata near Brussels. These species, belonging to what has been termed by M. Dumont the *Système Laekenien*, are sixty-five in number, eighteen of which are at present peculiar, but I have no doubt that this proportion might easily be reduced, inasmuch as the researches of the late Mr. Dixon in the Eocene deposit of Bracklesham, near Chichester, have brought to light many Mollusca and Bryozoa identical with Laeken fossils. Out of fifty-seven named Laeken shells, no less than forty-four are common to the *Calcaire grossier*, or beds of the same age in England. Such being the case, we have no reason to feel surprised that the fossils of the ferruginous sands of Mont Noir, near Cassel, which overlie strata corresponding in age to the Laeken beds of Brussels, should nevertheless contain shells which agree with the Bagshot and Bracklesham fauna of England. In other words, the *Système Laekenien* is simply one of several upper divisions of the *Calcaire grossier*.

It may, at first sight, seem strange that there are not more species common to the Cassel and Brussels lists, only thirty-two named species being common out of a total of 122; also that in each district so few species are common to the upper and lower divisions, at Cassel only sixteen out of sixty-two named species being common to the upper and lower series, and at Brussels only fifteen out of ninety-two species. How are we to reconcile such a result with the fact that each of these sets of fossils, when compared to the *Calcaire grossier* or Middle Eocene of England and France, exhibits nearly an equal amount of identity? The apparent inconsistency is, I think, removed when we recollect that each of the asterisk columns of Table XIII. represents a mere fraction of a great fauna obtained from the Middle Eocene beds of the south-east of England or from the Paris Basin. The analogous degree of relationship of the Cassel and Brussels fauna to one and the same foreign equivalent shows that they would

each approximate much nearer to each other, if we were able to extend our knowledge of the fossils of the respective districts; although there would still remain some distinctions arising from variations of species in space or in time; the representation of each precise stage, or division in time, of the fossils of the same Middle Eocene group being always imperfect, and usually unequally so in the several countries compared. The small number common to the "upper and lower Brussels" beds, or to the upper and lower Cassel beds, *i. e.* to the Upper and Middle Nummulitic, is no doubt in part the effect of change of species in time, and corresponds to the distinction between the Barton beds and the lower Bagshot (or lower Bracklesham) in England, or that of the *Sables moyens* (*grès de Beauchamp*) and the *Glauconie grossière* in France.

The number of Plants, Zoophytes, and Vertebrata common to the different divisions, or to the two districts, is too small to require me to dwell upon them. So far as they go, they coincide in their bearing with the conclusions to which we are led by the fossil Mollusca.

[2.] *Middle Eocene strata near Mons. Mont Panisel.*

It is well known that in the neighbourhood of Mons (about thirty-five English miles S.S.W. of Brussels) the Maestricht chalk is seen at Ciply, and above it are sands and clays (at Chasse Royale and other places), referred to the *Système Landenien* of Dumont. At a higher level, strata containing *Nummulites planulatus* in abundance have been found in wells sunk in the city of Mons. I found the same Nummulite in Mont Panisel, in the suburbs, sparingly dispersed through beds of clay and in greenish and yellowish ferruginous sands in which were some cherty beds containing casts of fossils with silicified shells. I examined Mont Panisel in company with M. A. Vanoilliez and M. Ch. De Beaulieu, and with their assistance obtained the following fossils:—

Nummulites planulatus.	Tellina.
Pinna margaritacea; abundant.	Nucula.
Loripes divaricata,	Crassatella.
Cardium porulosum?	Astarte.
Cassidaria nodosa.	Cardita.
Natica patula?	Fusus.
Lucina gibbosa.	Voluta.
Solen.	

These seem to be inferior to the Brussels Beds, of which the fossils are enumerated in the "Lower Brussels" column of Table XIII.

[3.] *Renaix, Craye, and Audenaerde.*

From the hills of Renaix, Mont Panisel above-mentioned may be seen. Near Renaix, about two miles S.E. of the town (see Map, Pl. XVII.), the stony beds with *Nummulites planulatus* are exposed to view in the bed of a small brook, where they are associated with clays and sands. The locality alluded to occurs in the Commune of St. Sauveur, on the farms of Tombelles and Arabie, where I was

conducted to a fine section by M. E. Joly, Advocate, well known for his antiquarian researches. Beds of clay, alternating with greenish sands and brick-earth, cover the solid layers of Nummulite-limestone to a thickness of 100 feet, and among them occur indurated siliceous sandstones similar to those in Mont Panisel, before-mentioned, with chalcedonic casts of shells, *Pinna margaritacea* being very abundant. The following fossils, collected by myself, or given me by M. Joly, are from this place or from Ellezelles near Renaix :—

Turbinolia sulcata, *Lamk.*
Solen.
Corbula, cast.
Tellina donacialis ?, *Edwards.*
Tellina.
Cytherea, near *C. obliqua*, Desh.
——, near *C. nitidula* ?, Lamk.
Cardita planicostata, *Lamk.*
Nucula margaritacea, *Lamk.*
Pinna margaritacea, *Lamk.*
Pecten.
Ostrea flabellula, *Lamk.*
Turritella imbricataria, *Lamk.*
Natica, allied to *N. Hantoniensis*, Sow.
Natica.
Fusus longævus, *Lamk.*
Pleurotoma.
Rostellaria fissurella, *Lamk.*
Cassidaria carinata, *Lamk.*
Voluta luctator ?, *Sow.*
——, two other species.
Terebellum.
Cypræa.
Nautilus, cast.
Cancer Leachii ?, *Desm.*
Xanthopsis, M'Coy.

At Kraye (or Craye), to the N.W. of Renaix, on a road leading from Renaix to Berchem on the Scheldt, I found sands with dispersed specimens of a variety of *Nummulites planulatus*, about 150 feet higher in the series than the solid beds at the farm of Arabie before-mentioned. These upper grey sands with green grains contain in great abundance an orbicular variety of *Cardita planicostata*, with *Cardium porulosum*, *Corbula*, &c.

At Audenaerde I observed beds similar to those of Renaix and Mont Panisel, the *Pinna margaritacea* being abundant in cherty beds which are sometimes used for pavement.

[4.] *Courtray.*

Three miles south of Courtray I found a tertiary clay, extensively worked for brick-making, which abounded in *Nummulites planulatus* in a very perfect state of preservation. I was directed to this region as likely to afford fossil remains by M. Dumont. The clay of Courtray evidently belongs to the Lower Nummulitic division, E. 3 of Table I. p. 279.

The fossils which accompanied the Nummulites, including a *Turritella* and some others, were too imperfect to admit of being specifically determined.

[5.] *Ghent.*

About three miles south of Ghent, at the country-house of M. F. Loozberg, an artesian well had been sunk to the depth of 70 metres at the time of my visit. The upper 35 metres consisted of sandy and clayey glauconites, with *Nummulites planulatus* dispersed through them at several levels. In examining this Glauconite Mr. Rupert Jones has lately found a few specimens of two species of Entomostraca, viz. *Cythere angulatopora*, Bosq., and *Cytherella Munsteri*,

Rœm. sp., both which (according to M. Bosquet*) occur in the Eocene strata of France. The lower half was made up of stiffer clay of a bright green colour, and lower down of darker colour, in which I found no Nummulites. As the Brussels beds with *Nautilus Burtini* occur in the trenches of the citadel at Ghent, I imagine the green sands of this well to belong to E. 3 of Table I., or the *Système Ypresien* of M. Dumont. It may perhaps be found possible and convenient to draw here and elsewhere a line of demarcation between the Ypres beds and the London Clay proper at the point where the Nummulites cease. Whether the beds containing *N. planulatus* near Ghent or Courtray may correspond in age with an upper division of the London Clay proper, or with the lowest part of the Bagshot series, cannot as yet be decided.

[6.] *Mons-en-Pevelle, near Lille.*

At no locality visited by me were the bands of Nummulitic limestone so conspicuous as at Mons-en-Pevelle, about nine miles south of Lille, to which my attention was directed by M. Meugy. The thickness of the formation (overlying the London Clay) to which they belong is estimated by that geologist at about 100 feet. I saw the layers of nummulitic rock, from 6 to 8 inches thick, extending throughout a thickness of about 60 feet of sandy and clayey beds. Not only were the roads made of them, but several buildings were in part constructed of the same, and I saw the yard of a farm-house paved with nummulitic slabs. With the exception of a *Dentalium* (*D. Deshayesianum*), I could find no fossils in the associated strata. In this part of French Flanders the lower nummulitic beds are separated from the Chalk by about 150 feet of London Clay, and nearly 100 more of Plastic clay and sand.

§ 8. *London Clay proper* (F. 1. Table I.). *Argile Ypresien, étage inférieur*, Dumont.

I have already stated, p. 331, that at the railway-station at Cassel a mass of brown clay with septaria was bored to the depth of 100 metres, and the bottom not reached. In uniformity of aspect it resembled the clay of Highgate and other places near London, and the absence of shells in the large heaps of clay extracted from the well, which I examined carefully, might be paralleled by a similar dearth of fossils in numerous sections in the London and Hampshire basins. The green sands and clays above the London Clay in the Hill of Cassel much resemble those containing *Nummulites planulatus* elsewhere, although I could not meet with that fossil at Cassel.

Near Lille a mass of clay, estimated by M. Meugy to be about 44 metres (or 145 feet) thick, underlies the *Nummulites planulatus* sands and limestone of Mons-en-Pevelle already described, and under that again are sands and clays, probably corresponding to the Plastic

* Descript. des Entom. Foss. des Terrains Tertiaires de la France et de la Belgique, Mém. Couron. Acad. Roy. Belg. vol. xxiv.

clay and sand near London. No progress seems yet to have been made here or elsewhere in obtaining fossils from the *argile Ypresien*, whether in French Flanders or Belgium. In the latter country this clay appears to be feebly developed, or usually wanting, as in the Paris basin.

At Bailleul, between Cassel and Lille (see Map, Pl. XVII.), many shells were met with in boring a well through this clay, but they were not preserved.

At Brussels, a mass of clay, lying over the Chalk and about 80 feet thick, was found in boring wells. It is separated from the chalk, as before stated (p. 350), by a band of flint-pebbles coated with green earth. There are not sufficient data as yet for deciding whether part of this clay should be referred to the London Clay proper.

§ 9. *Plastic Clay, Sand, and Lignite* (F. 2. Table I. p. 279). *Système Landenien supérieur*, Dumont. *Lower London Tertiaries*, Prestwich.

1. *Carvin, near Lille.*

Below the London Clay near Lille are sands and clays, about 80 feet thick, which resemble the beds near London usually called "Plastic clay and sand." The only fossils as yet found in them are marine, and occur in a clay, not more than 25 or 30 feet above the chalk. M. Meugy took me to the junction of the chalk and tertiary strata at Carvin, twelve miles south of Lille (see Map, Pl. XVII.). Within 300 yards of the church of Carvin we saw an open well just dug, where the White Chalk with flints appeared within 10 feet of the surface. Upon it there was no parting band of pebbles, but, in contact, schistose sandy clay, greenish but not glauconiferous, with a few well-rolled black pebbles interspersed. This clay or loam was 10 feet thick. At a short distance, and no doubt incumbent on the above, a tenacious clay occurs, several feet thick, which is worked for pottery; and above this again, in another pit, the sandy clay with concretions in which shells abound. Among these the *Cyprina Morrisii*, Sowerby ('Min. Con.' vol. vii. p. 20, pl. 620), abounds, which is characteristic of the Plastic Clay near London, and a *Turritella*, *Arca*, and *Corbula*, in casts too imperfect to admit of being specifically determined. There are white sands with some solid beds of sandstone in them near Lille, between the clay with *Cyprina Morrisii*, above-mentioned, and the London Clay, but I saw no good sections.

2. *Jauche, Huppaye, Oplinter, &c.*

In Belgium, above the "Lower Landenian," which I shall presently describe, and below the Brussels beds with *Nummulites planulatus*, there occurs a formation of sand, siliceous paving-stone, and lignite, to which the name of *Landenien supérieur* has been given by M. Dumont. As no fossil shells have been found in it, I cannot identify it palæontologically with that part of the British Tertiaries with which it may probably be contemporaneous. I saw its super-

position to the Lower Landenian near Jauche, on the road leading to Enines (Map, fig. 2, Pl. XVII.), where it is 40 feet thick, and consists of alternating yellow and whitish sands, resembling the "striped sands" of Lewisham and Woolwich, and, like the British "Lower Tertiaries," containing a bed of lignite. At a higher level in the series, at Huppaye, in the same district, this formation contains snow-white sands with beds of hard paving-stone or siliceous sandstone, from 7 to 10 feet thick. I saw the same "striped sands" at Marilles, about one league north-east of Huppaye, traversed by a layer of well-rounded flint-pebbles. In the neighbourhood of Tirlemont I found fragments of silicified wood in this part of the series, and at Oplinter, a few miles north of Tirlemont, clay with lignite and the leaves of dicotyledonous trees. To this locality I was conducted by M. de Koninck. M. Dumont informed me that, at some points, the alternations of clay and beds of lignite in the middle portion of this series are very numerous. We may hope, therefore, that some fossil plants, at least, may hereafter be obtained.

Near the railway station at Landen I saw a section of the upper Landenian formation, consisting of white and yellow striped sands without fossils, about 35 feet thick.

§ 10. *Glauconite of Tournay and Angres* (G. Table I. p. 279). *Beds between the Plastic Clay and the Chalk of Maestricht. Système Landenien inférieur,* Dumont.

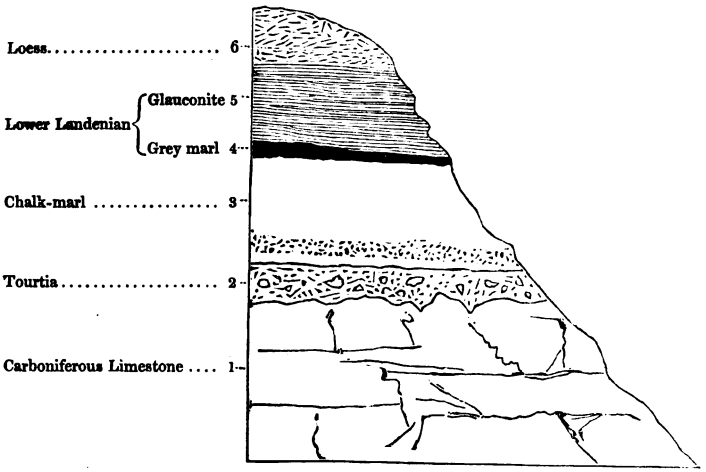
I have next to describe strata which are certainly older than those last alluded to, but concerning the relations of which to the Tertiary or the Cretaceous series, much difference of opinion exists. The localities where I examined this series, called "Lower Landenian" by M. Dumont, were:—1. Tournay. 2. Angres, near Quiévrain, about fourteen miles S.W. of Mons: see Map, fig. 1, Pl. XVII. 3. In the province of Hesbaye, at Folx-les-Caves, Orp-le-Grand, Lincent, and several other places.

1. *Tournay.*

About two miles from the Valenciennes gate of Tournay, on the left bank of the Scheldt, are some large quarries deeply excavated in the Mountain or Carboniferous limestone. In one belonging to M. Dapsens Carbonnel, the limestone (1) is seen covered as in the accompanying section, fig. 10, with a well-known member of the chalk, provincially called "tourtia" (2), above which is white chalk-marl (3), with the usual fossils, upon which rest strata (4, 5), referred by M. Dumont and others to the tertiary series, and called in Belgium "Lower Landenian." The lowest of these is an argillaceous grey marl (4), strongly contrasted in its darker colour with the white chalk-marl. I found in this grey marl (4) a perfect specimen of a well-known chalk fossil, *Terebratula gracilis,* Schlotheim (*T. rigida,* Sow., 'Min. Conch.' vol. vi. p. 69, pl. 536. fig. 2), with both valves united. With this was *Terebratula striatula,* in abundance, also *Ostrea* (*Exogyra*) *lateralis,* Nyst, and a *Bryozoon.*

Reposing on the marl (4) and passing into it at the junction are

Fig. 10.—*Section near Tournay.*



beds of a green sandy glauconite (5) 10 feet thick, in the upper part of which layers of cherty stone from 6 to 8 inches thick abound, with casts of shells. In this glauconite the same *Ostrea lateralis* and *Terebratula striatula* occur which are met with in the grey marl (4), so that it seemed to me impossible to draw a line between the beds "4" and "5," or to consider "4" as cretaceous and "5" tertiary. The other fossils which I found in "5" consisted of a *Pholadomya* (*P. Koninckii*?), *Cucullæa*, *Pinna*, *Turritella*, *Fusus*, *Natica*, &c., chiefly casts, and these in too unsatisfactory a state to admit of being specifically distinguished. A gigantic *Pleurotomaria*, sometimes retaining its shell, is not uncommon in these beds, and is very unlike any fossil occurring in the Lower Tertiaries of England or France. It resembles rather the *P. gigantea* of the Lower Greensand. One species, and as yet one only, of this genus, is known in the *Calcaire grossier*,—*P. concava* of Deshayes ('Coq. Foss. de Paris,' vol. ii. pl. 32. fig. 1, 2, 3), much smaller in size, though somewhat analogous in form. According to Baron Ryckholt, who possesses the finest collection of shells from the glauconite of Tournay, all the species which have been referred to tertiary shells are distinct. Not a few of them he considers identical with fossils of the Faxoe, Maestricht, and other cretaceous formations. The difficulty of defining the specific characters in the genera *Pholadomya*, *Scalaria*, *Mya*, and *Pinna*, without having a full and perfect series of the individuals for comparison, is such that I cannnot pretend, without better specimens than I brought from Tournay and Angres, to offer a positive opinion on this point. I believe nevertheless that Baron Ryckholt, when he publishes a full account of his valuable collection, will succeed in proving the beds in question to be older than any fossiliferous strata above the Chalk in England.

2. *Angres, near Quiévrain.*

At Angres, near the southern frontiers of Belgium, fourteen English miles south-west of Mons, the White Chalk with flints is covered with a solid glauconite, free from calcareous matter, and full of the casts of shells. I visited this place in company with M. de Beaulieu, Professor of the École des Mines at Mons. We found a section in a hollow way, within half a mile N.N.E. of the church of Angres, where a thickness of 25 feet of thin-bedded and half-solidified glauconite is seen. The stone at some points becomes very hard, and the green grains are larger and more widely scattered in the upper beds. I obtained the casts of about fifteen shells, belonging to the genera

Arca.	Venus?
Cucullæa (allied to *C. decussata*).	Tellina.
Panopæa (like *P. intermedia*?).	Pinna.
Pectunculus.	Ostrea.
Crassatella.	Turritella.
Nucula.	Lucina?
Pholadomya (resembling *P. cuneata*, Sow. M. C. pl. 630).	Natica.
Astarte.	Calyptræa.

Also a Bryozoon (Retepora?) and an Echinoderm.

The casts were many of them decidedly the same as those already mentioned as occurring near Tournay. We afterwards saw a similar glauconite with similar fossils at Baisieux, two miles north of Angres, and about a mile south of Quiévrain.

The matrix of the shells at Angres is sometimes quite undistinguishable from that Middle Eocene glauconite, with large coarse grains of green earth, which occurs at Boeschepe near Cassel, before described, p. 325, and in which casts of a large *Ovula* and other shells occur. It is one of many instances in Belgium of the identity in mineral character of tertiary beds of very different ages, to which the abundance of glauconite particularly contributes.

3. *Folx-les-Caves, Jauche, Jendrain, Orp-le-grand, &c.*

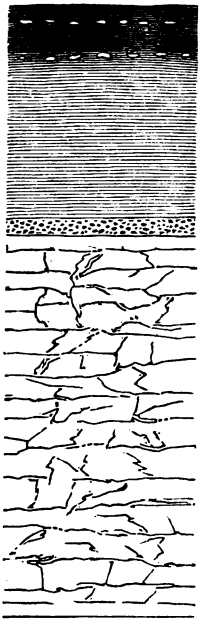
I shall now pass to another part of Belgium (between Brussels and Liege, seventy or eighty miles eastward of Tournay), where strata, also called "Lower Landenian," and probably of about the same age as those of Tournay and Angres already described, are met with in the cantons of Landen, Jodoigne, and Tirlemont. See Map, fig. 2, Pl. XVII.

At Folx-les-Caves, the most southern point where I saw this formation, it rests on the Maestricht Chalk, fig. 11, I, which is there quarried to the depth of 20 feet for building-stone, and exhibits *Belemnites mucronatus* and other characteristic fossils.

The chalk is covered by a bed of rolled flint-pebbles, some of which are 4 inches in their longest diameter. This bed (G. 2), forming the base of the "Lower Landenian," is 1 foot thick, and supports a stratum (G. 1) of soft glauconite, 6 feet thick, the upper part of which is clayey, and contains some small dark concretions, which, like the greensand matrix, are highly calcareous. The fossils in the

glauconite (G. 1) consist chiefly of *Astarte inæquilateralis*, Nyst, well-preserved and often with both valves united. On one of these I found a small attached coral (*Dendrophyllia*). In the same bed a large species of *Dentalium* occurs, and some casts of Bivalves.

Fig. 11.—*Section at Folx-les-Caves.*



	ft.
G 1. Glauconite; upper part clayey, with small concretions	6
G 2. Pebble-bed	1
I. Maestricht Chalk	20 exposed.

No other member of the "Lower Landenian" is seen at Folx-les-Caves, but a solid and whitish glauconite, called by Omalius d'Halloy *tufeau de Lincent*, occupying a higher position in the same series, is met with at the distance of three or four miles to the north and west, as at the village of Jauche, where there is a hollow lane in which the whitish tufeau and greenish sand or soft glauconite are seen to attain a thickness of about 20 feet, and greatly to resemble in character some members of the Chalk and Upper Greensand of many parts of Europe. The tufeau is highly calcareous and of small specific gravity, hence it is of cheap carriage and highly useful as a building-stone. Some of the beds are cherty; casts of a small *Nucula* (*Leda*) are most common in the tufeau. In part of the region alluded to, the Lower Landenian rests immediately on White Chalk with flints without the intervention of the Maestricht chalk, as at Jandrain, and sometimes, as in the immediate neighbourhood of that village and on the road from it to Orp-le-Grand, the Maestricht chalk is reduced to a thickness of less than 2 feet between the White Chalk with flints and the overlying Landenian. The Maestricht bed here contains large concretions of silex, more or less pure, and is full of

Thecidea radians and *Belemnites mucronatus*, with *Terebratulæ* and other characteristic fossils; it contains also many rolled pebbles of flint near its junction with the White Chalk. This fact is important, as showing that the White Chalk with flints had suffered denudation previously to the deposition of the Maestricht beds. The occurrence of rolled pebbles at the base of the Maestricht rock is analogous to the pebbly glauconite which separates the Maestricht chalk from the Lower Landenian, so that the parting layer of pebbles, which at Folx-les-Caves might seem, at first sight, to afford good ground for separating the cretaceous and tertiary formations, loses all importance as a line of demarcation. The upheaval and exposure of the secondary rocks had evidently begun before the termination of the cretaceous period.

In the middle of the village of Jendrain above mentioned a chalk-pit has been opened, where the White Chalk with flints is covered immediately by the Lower Landenian containing the wreck of the Maestricht chalk, and its flints or cherty rock, which consist of huge flattened masses, several feet in diameter. At Wanzin (Map, fig. 2. Pl. XVII.), I saw several sections where the surface of the White Chalk had been much denuded, and where the whitish glauconite or tufeau of the Lower Landenian, characterized by *Astarte inæquilatera*, filled up inequalities scooped out of the older rock.

4. *Orp-le-Grand, Pellaines, Lincent, and Amptieau.*

At Orp-le-Grand the light tufeau is quarried for building purposes to a depth of more than 20 feet. One of the most conspicuous fossils, called *Gyrolites* (*Vermiculites* of Nyst), resembles the tubular cavities left by a large boring Annelid, and traverses the stone in curves several inches in diameter. The *Astarte inæquilatera* connects this rock with the glauconite before mentioned of Folx-les-Caves. The *Pholadomya Koninckii*, also abundant, forms a link between it and the glauconite of Tournay, before mentioned, p. 362. With these shells I found a cast and impression of a large *Scalaria*, which appears undistinguishable, so far as a cast will admit of comparison, with a species in Mr. Bowerbank's cabinet from the Lower London Tertiaries or Thanet Sands. The other shells are *Dentalium*, casts of *Cucullæa*, *Arca*, *Nucula*, *Turritella*, *Natica*, and *Pleurotoma*?, with teeth of *Lamna*. I found also two species of Echinoderms, one of them, according to Professor E. Forbes, of the genus *Hemiaster*, a form belonging equally to the cretaceous and tertiary periods; and the other referred to *Cardiaster* by the same authority, who remarks that this genus has hitherto been only met with in *cretaceous* strata. This discovery is interesting in its bearing on the question whether the Lower Landenian fauna has most relationship with a cretaceous or a tertiary type, or whether it be not intermediate in character and

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Nucula margaritacea, *Lamk.*
Pinna margaritacea, *Lamk.*
Pecten.
Ostrea flabellula, *Lamk.*
Turritella imbricataria, *Lamk.*
Natica, allied to *N. Hantoniensis*, Sow.
Natica.
Fusus longævus, *Lamk.*
Pleurotoma.
Rostellaria fissurella, *Lamk.*
Cassidaria carinata, *Lamk.*
Voluta luctator ?, *Sow.*
——, two other species.
Terebellum.
Cypræa.
Nautilus, cast.
Cancer Leachii ?, *Desm.*
Xanthopsis, M'Coy.

At Kraye (or Craye), to the N.W. of Renaix, on a road leading from Renaix to Berchem on the Scheldt, I found sands with dispersed specimens of a variety of *Nummulites planulatus*, about 150 feet higher in the series than the solid beds at the farm of Arabie before-mentioned. These upper grey sands with green grains contain in great abundance an orbicular variety of *Cardita planicostata*, with *Cardium porulosum*, *Corbula*, &c.

At Audenaerde I observed beds similar to those of Renaix and Mont Panisel, the *Pinna margaritacea* being abundant in cherty beds which are sometimes used for pavement.

[4.] *Courtray.*

Three miles south of Courtray I found a tertiary clay, extensively worked for brick-making, which abounded in *Nummulites planulatus* in a very perfect state of preservation. I was directed to this region as likely to afford fossil remains by M. Dumont. The clay of Courtray evidently belongs to the Lower Nummulitic division, E. 3 of Table I. p. 279.

The fossils which accompanied the Nummulites, including a *Turritella* and some others, were too imperfect to admit of being specifically determined.

[5.] *Ghent.*

About three miles south of Ghent, at the country-house of M. F. Loozberg, an artesian well had been sunk to the depth of 70 metres at the time of my visit. The upper 35 metres consisted of sandy and clayey glauconites, with *Nummulites planulatus* dispersed through them at several levels. In examining this Glauconite Mr. Rupert Jones has lately found a few specimens of two species of Entomostraca, viz. *Cythere angulatopora*, Bosq., and *Cytherella Munsteri*,

Rœm. sp., both which (according to M. Bosquet*) occur in the Eocene strata of France. The lower half was made up of stiffer clay of a bright green colour, and lower down of darker colour, in which I found no Nummulites. As the Brussels beds with *Nautilus Burtini* occur in the trenches of the citadel at Ghent, I imagine the green sands of this well to belong to E. 3 of Table I., or the *Système Ypresien* of M. Dumont. It may perhaps be found possible and convenient to draw here and elsewhere a line of demarcation between the Ypres beds and the London Clay proper at the point where the Nummulites cease. Whether the beds containing *N. planulatus* near Ghent or Courtray may correspond in age with an upper division of the London Clay proper, or with the lowest part of the Bagshot series, cannot as yet be decided.

[6.] *Mons-en-Pevelle, near Lille.*

At no locality visited by me were the bands of Nummulitic limestone so conspicuous as at Mons-en-Pevelle, about nine miles south of Lille, to which my attention was directed by M. Meugy. The thickness of the formation (overlying the London Clay) to which they belong is estimated by that geologist at about 100 feet. I saw the layers of nummulitic rock, from 6 to 8 inches thick, extending throughout a thickness of about 60 feet of sandy and clayey beds. Not only were the roads made of them, but several buildings were in part constructed of the same, and I saw the yard of a farm-house paved with nummulitic slabs. With the exception of a *Dentalium* (*D. Deshayesianum*), I could find no fossils in the associated strata. In this part of French Flanders the lower nummulitic beds are separated from the Chalk by about 150 feet of London Clay, and nearly 100 more of Plastic clay and sand.

§ 8. *London Clay proper* (F. 1. Table I.). *Argile Ypresien, étage inférieur*, Dumont.

I have already stated, p. 331, that at the railway-station at Cassel a mass of brown clay with septaria was bored to the depth of 100 metres, and the bottom not reached. In uniformity of aspect it resembled the clay of Highgate and other places near London, and the absence of shells in the large heaps of clay extracted from the well, which I examined carefully, might be paralleled by a similar dearth of fossils in numerous sections in the London and Hampshire basins. The green sands and clays above the London Clay in the Hill of Cassel much resemble those containing *Nummulites planulatus* elsewhere, although I could not meet with that fossil at Cassel.

Near Lille a mass of clay, estimated by M. Meugy to be about 44 metres (or 145 feet) thick, underlies the *Nummulites planulatus* sands and limestone of Mons-en-Pevelle already described, and under that again are sands and clays, probably corresponding to the Plastic

* Descript. des Entom. Foss. des Terrains Tertiaires de la France et de la Belgique, Mém. Couron. Acad. Roy. Belg. vol. xxiv.

conducted to a fine section by M. E. Joly, Advocate, well known for his antiquarian researches. Beds of clay, alternating with greenish sands and brick-earth, cover the solid layers of Nummulite-limestone to a thickness of 100 feet, and among them occur indurated siliceous sandstones similar to those in Mont Panisel, before-mentioned, with chalcedonic casts of shells, *Pinna margaritacea* being very abundant. The following fossils, collected by myself, or given me by M. Joly, are from this place or from Ellezelles near Renaix :—

Turbinolia sulcata, *Lamk.*
Solen.
Corbula, cast.
Tellina donacialis ?, *Edwards.*
Tellina.
Cytherea, near *C. obliqua*, Desh.
——, near *C. nitidula* ?, Lamk.
Cardita planicostata, *Lamk.*
Nucula margaritacea, *Lamk.*
Pinna margaritacea, *Lamk.*
Pecten.
Ostrea flabellula, *Lamk.*
Turritella imbricataria, *Lamk.*
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clay and sand near London. No progress seems yet to have been made here or elsewhere in obtaining fossils from the *argile Ypresien*, whether in French Flanders or Belgium. In the latter country this clay appears to be feebly developed, or usually wanting, as in the Paris basin.

At Bailleul, between Cassel and Lille (see Map, Pl. XVII.), many shells were met with in boring a well through this clay, but they were not preserved.

At Brussels, a mass of clay, lying over the Chalk and about 80 feet thick, was found in boring wells. It is separated from the chalk, as before stated (p. 350), by a band of flint-pebbles coated with green earth. There are not sufficient data as yet for deciding whether part of this clay should be referred to the London Clay proper.

§ 9. *Plastic Clay, Sand, and Lignite* (F. 2. Table I. p. 279). *Système Landenien supérieur*, Dumont. *Lower London Tertiaries*, Prestwich.

1. *Carvin, near Lille.*

Below the London Clay near Lille are sands and clays, about 80 feet thick, which resemble the beds near London usually called "Plastic clay and sand." The only fossils as yet found in them are marine, and occur in a clay, not more than 25 or 30 feet above the chalk. M. Meugy took me to the junction of the chalk and tertiary strata at Carvin, twelve miles south of Lille (see Map, Pl. XVII.). Within 300 yards of the church of Carvin we saw an open well just dug, where the White Chalk with flints appeared within 10 feet of the surface. Upon it there was no parting band of pebbles, but, in contact, schistose sandy clay, greenish but not glauconiferous, with a few well-rolled black pebbles interspersed. This clay or loam was 10 feet thick. At a short distance, and no doubt incumbent on the above, a tenacious clay occurs, several feet thick, which is worked for pottery; and above this again, in another pit, the sandy clay with concretions in which shells abound. Among these the *Cyprina Morrisii*, Sowerby ('Min. Con.' vol. vii. p. 20, pl. 620), abounds, which is characteristic of the Plastic Clay near London, and a *Turritella*, *Arca*, and *Corbula*, in casts too imperfect to admit of being specifically determined. There are white sands with some solid beds of sandstone in them near Lille, between the clay with *Cyprina Morrisii*, above-mentioned, and the London Clay, but I saw no good sections.

2. *Jauche, Huppaye, Oplinter, &c.*

In Belgium, above the "Lower Landenian," which I shall presently describe, and below the Brussels beds with *Nummulites planulatus*, there occurs a formation of sand, siliceous paving-stone, and lignite, to which the name of *Landenien supérieur* has been given by M. Dumont. As no fossil shells have been found in it, I cannot identify it palæontologically with that part of the British Tertiaries with which it may probably be contemporaneous. I saw its super-

position to the Lower Landenian near Jauche, on the road leading to Enines (Map, fig. 2, Pl. XVII.), where it is 40 feet thick, and consists of alternating yellow and whitish sands, resembling the "striped sands" of Lewisham and Woolwich, and, like the British "Lower Tertiaries," containing a bed of lignite. At a higher level in the series, at Huppaye, in the same district, this formation contains snow-white sands with beds of hard paving-stone or siliceous sandstone, from 7 to 10 feet thick. I saw the same "striped sands" at Marilles, about one league north-east of Huppaye, traversed by a layer of well-rounded flint-pebbles. In the neighbourhood of Tirlemont I found fragments of silicified wood in this part of the series, and at Oplinter, a few miles north of Tirlemont, clay with lignite and the leaves of dicotyledonous trees. To this locality I was conducted by M. de Koninck. M. Dumont informed me that, at some points, the alternations of clay and beds of lignite in the middle portion of this series are very numerous. We may hope, therefore, that some fossil plants, at least, may hereafter be obtained.

Near the railway station at Landen I saw a section of the upper Landenian formation, consisting of white and yellow striped sands without fossils, about 35 feet thick.

§ 10. *Glauconite of Tournay and Angres* (G. Table I. p. 279). *Beds between the Plastic Clay and the Chalk of Maestricht. Système Landenien inférieur*, Dumont.

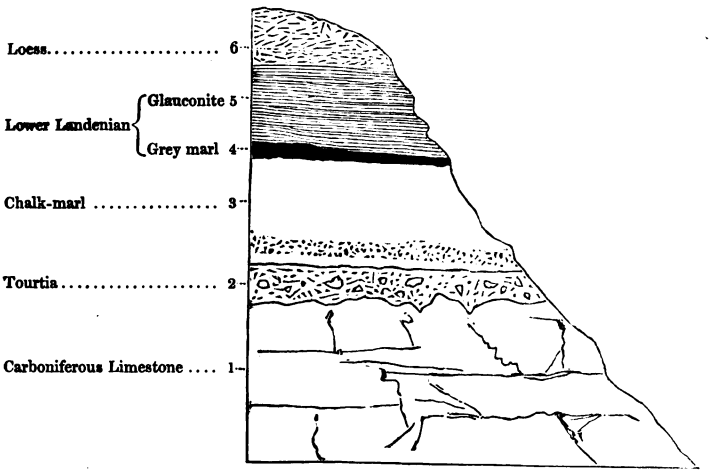
I have next to describe strata which are certainly older than those last alluded to, but concerning the relations of which to the Tertiary or the Cretaceous series, much difference of opinion exists. The localities where I examined this series, called "Lower Landenian" by M. Dumont, were:—1. Tournay. 2. Angres, near Quiévrain, about fourteen miles S.W. of Mons: see Map, fig. 1, Pl. XVII. 3. In the province of Hesbaye, at Folx-les-Caves, Orp-le-Grand, Lincent, and several other places.

1. *Tournay.*

About two miles from the Valenciennes gate of Tournay, on the left bank of the Scheldt, are some large quarries deeply excavated in the Mountain or Carboniferous limestone. In one belonging to M. Dapsens Carbonnel, the limestone (1) is seen covered as in the accompanying section, fig. 10, with a well-known member of the chalk, provincially called "tourtia" (2), above which is white chalk-marl (3), with the usual fossils, upon which rest strata (4, 5), referred by M. Dumont and others to the tertiary series, and called in Belgium "Lower Landenian." The lowest of these is an argillaceous grey marl (4), strongly contrasted in its darker colour with the white chalk-marl. I found in this grey marl (4) a perfect specimen of a well-known chalk fossil, *Terebratula gracilis*, Schlotheim (*T. rigida*, Sow., 'Min. Conch.' vol. vi. p. 69, pl. 536. fig. 2), with both valves united. With this was *Terebratula striatula*, in abundance, also *Ostrea* (*Exogyra*) *lateralis*, Nyst, and a *Bryozoon*.

Reposing on the marl (4) and passing into it at the junction are

Fig. 10.—*Section near Tournay.*



beds of a green sandy glauconite (5) 10 feet thick, in the upper part of which layers of cherty stone from 6 to 8 inches thick abound, with casts of shells. In this glauconite the same *Ostrea lateralis* and *Terebratula striatula* occur which are met with in the grey marl (4), so that it seemed to me impossible to draw a line between the beds "4" and "5," or to consider "4" as cretaceous and "5" tertiary. The other fossils which I found in "5" consisted of a *Pholadomya* (*P. Koninckii*?), *Cucullæa*, *Pinna*, *Turritella*, *Fusus*, *Natica*, &c., chiefly casts, and these in too unsatisfactory a state to admit of being specifically distinguished. A gigantic *Pleurotomaria*, sometimes retaining its shell, is not uncommon in these beds, and is very unlike any fossil occurring in the Lower Tertiaries of England or France. It resembles rather the *P. gigantea* of the Lower Greensand. One species, and as yet one only, of this genus, is known in the *Calcaire grossier*,—*P. concava* of Deshayes ('Coq. Foss. de Paris,' vol. ii. pl. 32. fig. 1, 2, 3), much smaller in size, though somewhat analogous in form. According to Baron Ryckholt, who possesses the finest collection of shells from the glauconite of Tournay, all the species which have been referred to tertiary shells are distinct. Not a few of them he considers identical with fossils of the Faxoe, Maestricht, and other cretaceous formations. The difficulty of defining the specific characters in the genera *Pholadomya*, *Scalaria*, *Mya*, and *Pinna*, without having a full and perfect series of the individuals for comparison, is such that I cannot pretend, without better specimens than I brought from Tournay and Angres, to offer a positive opinion on this point. I believe nevertheless that Baron Ryckholt, when he publishes a full account of his valuable collection, will succeed in proving the beds in question to be older than any fossiliferous strata above the Chalk in England.

2. *Angres, near Quiévrain.*

At Angres, near the southern frontiers of Belgium, fourteen English miles south-west of Mons, the White Chalk with flints is covered with a solid glauconite, free from calcareous matter, and full of the casts of shells. I visited this place in company with M. de Beaulieu, Professor of the École des Mines at Mons. We found a section in a hollow way, within half a mile N.N.E. of the church of Angres, where a thickness of 25 feet of thin-bedded and half-solidified glauconite is seen. The stone at some points becomes very hard, and the green grains are larger and more widely scattered in the upper beds. I obtained the casts of about fifteen shells, belonging to the genera

Arca.	Venus?
Cucullæa (allied to *C. decussata*).	Tellina.
Panopæa (like *P. intermedia*?).	Pinna.
Pectunculus.	Ostrea.
Crassatella.	Turritella.
Nucula.	Lucina?
Pholadomya (resembling *P. cuneata*, Sow. M. C. pl. 630).	Natica.
Astarte.	Calyptræa.

Also a Bryozoon (Retepora?) and an Echinoderm.

The casts were many of them decidedly the same as those already mentioned as occurring near Tournay. We afterwards saw a similar glauconite with similar fossils at Baisieux, two miles north of Angres, and about a mile south of Quiévrain.

The matrix of the shells at Angres is sometimes quite undistinguishable from that Middle Eocene glauconite, with large coarse grains of green earth, which occurs at Boeschepe near Cassel, before described, p. 325, and in which casts of a large *Ovula* and other shells occur. It is one of many instances in Belgium of the identity in mineral character of tertiary beds of very different ages, to which the abundance of glauconite particularly contributes.

3. *Folx-les-Caves, Jauche, Jendrain, Orp-le-grand, &c.*

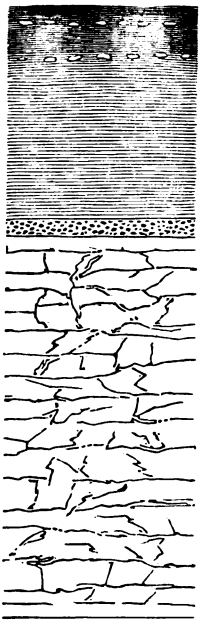
I shall now pass to another part of Belgium (between Brussels and Liege, seventy or eighty miles eastward of Tournay), where strata, also called "Lower Landenian," and probably of about the same age as those of Tournay and Angres already described, are met with in the cantons of Landen, Jodoigne, and Tirlemont. See Map, fig. 2, Pl. XVII.

At Folx-les-Caves, the most southern point where I saw this formation, it rests on the Maestricht Chalk, fig. 11, I, which is there quarried to the depth of 20 feet for building-stone, and exhibits *Belemnites mucronatus* and other characteristic fossils.

The chalk is covered by a bed of rolled flint-pebbles, some of which are 4 inches in their longest diameter. This bed (G. 2), forming the base of the "Lower Landenian," is 1 foot thick, and supports a stratum (G. 1) of soft glauconite, 6 feet thick, the upper part of which is clayey, and contains some small dark concretions, which, like the greensand matrix, are highly calcareous. The fossils in the

glauconite (G. 1) consist chiefly of *Astarte inæquilateralis*, Nyst, well-preserved and often with both valves united. On one of these I found a small attached coral (*Dendrophyllia*). In the same bed a large species of *Dentalium* occurs, and some casts of Bivalves.

Fig. 11.—*Section at Folx-les-Caves.*



	ft.
G 1. Glauconite; upper part clayey, with small concretions	6
G 2. Pebble-bed	1
I. Maestricht Chalk	20 exposed.

No other member of the "Lower Landenian" is seen at Folx-les-Caves, but a solid and whitish glauconite, called by Omalius d'Halloy *tufeau de Lincent*, occupying a higher position in the same series, is met with at the distance of three or four miles to the north and west, as at the village of Jauche, where there is a hollow lane in which the whitish tufeau and greenish sand or soft glauconite are seen to attain a thickness of about 20 feet, and greatly to resemble in character some members of the Chalk and Upper Greensand of many parts of Europe. The tufeau is highly calcareous and of small specific gravity, hence it is of cheap carriage and highly useful as a building-stone. Some of the beds are cherty; casts of a small *Nucula* (*Leda*) are most common in the tufeau. In part of the region alluded to, the Lower Landenian rests immediately on White Chalk with flints without the intervention of the Maestricht chalk, as at Jandrain, and sometimes, as in the immediate neighbourhood of that village and on the road from it to Orp-le-Grand, the Maestricht chalk is reduced to a thickness of less than 2 feet between the White Chalk with flints and the overlying Landenian. The Maestricht bed here contains large concretions of silex, more or less pure, and is full of

Thecidea radians and *Belemnites mucronatus*, with *Terebratulæ* and other characteristic fossils; it contains also many rolled pebbles of flint near its junction with the White Chalk. This fact is important, as showing that the White Chalk with flints had suffered denudation previously to the deposition of the Maestricht beds. The occurrence of rolled pebbles at the base of the Maestricht rock is analogous to the pebbly glauconite which separates the Maestricht chalk from the Lower Landenian, so that the parting layer of pebbles, which at Folx-les-Caves might seem, at first sight, to afford good ground for separating the cretaceous and tertiary formations, loses all importance as a line of demarcation. The upheaval and exposure of the secondary rocks had evidently begun before the termination of the cretaceous period.

In the middle of the village of Jendrain above mentioned a chalk-pit has been opened, where the White Chalk with flints is covered immediately by the Lower Landenian containing the wreck of the Maestricht chalk, and its flints or cherty rock, which consist of huge flattened masses, several feet in diameter. At Wanzin (Map, fig. 2. Pl. XVII.), I saw several sections where the surface of the White Chalk had been much denuded, and where the whitish glauconite or tufeau of the Lower Landenian, characterized by *Astarte inæquilatera*, filled up inequalities scooped out of the older rock.

4. *Orp-le-Grand, Pellaines, Lincent, and Amptieau.*

At Orp-le-Grand the light tufeau is quarried for building purposes to a depth of more than 20 feet. One of the most conspicuous fossils, called *Gyrolites* (*Vermiculites* of Nyst), resembles the tubular cavities left by a large boring Annelid, and traverses the stone in curves several inches in diameter. The *Astarte inæquilatera* connects this rock with the glauconite before mentioned of Folx-les-Caves. The *Pholadomya Koninckii*, also abundant, forms a link between it and the glauconite of Tournay, before mentioned, p. 362. With these shells I found a cast and impression of a large *Scalaria*, which appears undistinguishable, so far as a cast will admit of comparison, with a species in Mr. Bowerbank's cabinet from the Lower London Tertiaries or Thanet Sands. The other shells are *Dentalium*, casts of *Cucullæa*, *Arca*, *Nucula*, *Turritella*, *Natica*, and *Pleurotoma*?, with teeth of *Lamna*. I found also two species of Echinoderms, one of them, according to Professor E. Forbes, of the genus *Hemiaster*, a form belonging equally to the cretaceous and tertiary periods; and the other referred to *Cardiaster* by the same authority, who remarks that this genus has hitherto been only met with in *cretaceous* strata. This discovery is interesting in its bearing on the question whether the Lower Landenian fauna has most relationship with a cretaceous or a tertiary type, or whether it be not intermediate in character and in age. No Baculite, Belemnite, Ammonite, or other Cephalopod of a family peculiar to the Chalk, has hitherto been met with in these beds; but the same may be said of the true cretaceous strata in many regions.

I visited Pellaines and Lincent, where magnificent square blocks

and tall columns of the tufaceous building-stone are obtained from the quarries, and the same fossils as at Orp-le-Grand. At Amptieau I found the Lower Landenian passing into a white calcareo-argillaceous rock, much used as a fire-stone, in which I observed *Pholadomya Koninckii* and a small *Leda*, allied to *L. fragilis*. As usual in Belgium, a deep covering of loess renders it difficult to obtain sections.

It may be proper to mention here, that many decidedly Eocene shells have been cited from Orp-le-Grand and the other localities just alluded to, chiefly on the authority of M. Galeotti; but having failed to detect any of them *in situ* here or elsewhere in beds of this age, and having conversed with M. Galeotti himself, I am convinced that they were introduced into the published lists by mistake. These shells have not only been cited from M. Galeotti's memoir by M. Nyst and M. d'Omalius d'Halloy*, but more recently by M. d'Archiac†. Among these spurious fossils are *Nummulites lævigatus, Lunulites radiatus, Turbinolia sulcata, Cytherea nitidula, Lucina divaricata, Cardium porulosum, Cardita elegans, Ostrea flabellula, Dentalium Deshayesianum, Melania marginata, Cassidaria carinata, Solarium Nystii,* and other Eocene shells, not one of which has ever been met with in the "Lower Landenian" of Dumont.

§ 11. *Marls and Glauconite of Heers* (H. Table I. p. 279). *Système Heersien* of M. Dumont.

Between the formation last mentioned and the Maestricht chalk, there intervenes another series of strata, discovered by M. Dumont, and called by him *Heersien*, from the village of Heers (six miles N.N.E. of Waremme). These are best seen near the village of Oreye, at the farm of Vivier, about six miles N.E. of Waremme, where they consist of white marl, resting on sandy glauconite, and this last on Maestricht chalk.

I had no opportunity of examining this locality, but was conducted to another by M. Dumont at Marlinne, between Waremme and Looz, about fifteen miles E. of Orp-le-Grand, and four miles N. of Waremme, where this formation consisted of a white marl, 20 feet thick, as white as chalk, but not so soft, and containing leaves of dicotyledonous plants, but no shells. It is here seen to underlie the Lower Landenian, which reposes upon it in the form of a glauconite, similar to that of Folx-les-Caves. No progress has yet been made in comparing the species of dicotyledonous leaves with those found in other formations. Their occurrence affords no evidence of the tertiary nature of the Heersian strata, now that Dr. Debey has brought to light in the lower cretaceous beds of Aix-la-Chapelle so great a variety of the leaves of dicotyledonous plants‡.

It is clear, therefore, that there are in Belgium certain deposits, consisting of glauconites and marls, interposed between the Chalk

* Géologie de la Belgique, 1842. † Hist. des Progrès, vol. ii. p. 502, 1848.
‡ Entwurf zu einer Geogn. Darstellung der Gegend von Aachen, 1849. See also Quart. Journ. Geol. Soc. vol. vii. Part II. p. 109.

of Maestricht and beds of the age of the Lower London Tertiaries. The change in Europe from the Maestricht and Faxoe fauna to that of the Lower Eocene is so vast as to prepare us for the discovery of a long series of such intermediate rocks, characterized by species in part new and in part cretaceous or tertiary,—formations in which genera, hitherto regarded, like the *Cardiaster*, as exclusively secondary, and others only known before as tertiary, may be found associated. Instead of grouping all these monuments of an intervening period as Cretaceous or as Eocene, it may be convenient to introduce a new system, to which the *calcaire pisolitique* of France and the Heersian and Lower Landenian of Belgium may be referred.

In the Synoptical Table of tertiary formations, which has been introduced into an early part of this paper (p. 279), it will be seen that, so far as I have been able to ascertain, the Lower Landenian and Heersian groups have no exact equivalents in the British Islands. This opinion may require modification hereafter, when a fuller comparison has been instituted between the Lower Tertiary fossils of England and those of Belgium. In the meantime, the place assigned by M. Dumont to the Lower Landenian will be understood by consulting his Tables already alluded to (p. 279, *note*) and printed as Appendices Nos. I. and II. One of these was published in 1851, and the other appears now for the first time, having been recently communicated by the author, after his return from a geological excursion in England in the autumn of 1851. To him, and to all the other geologists of Belgium with whom I had the pleasure of conferring, I have to express my warmest thanks for their zealous and effective cooperation. I must also avail myself of this opportunity of acknowledging my obligations to MM. Nyst and De Koninck in particular, for their unremitting attentions during my tour, and their instructive correspondence since my return. In several of the principal districts, the reader cannot fail to have perceived that I should have made but little progress in the examination of their palæontology without such assistance as that afforded me at Antwerp by M. Norbert de Wael, at Brussels by Captain Le Hon, and in the Limburg by M. Bosquet. These naturalists have enabled me to present to the scientific world a more complete catalogue of the fossils of the several regions studied by each of them, than had previously been printed; and in each case, when they generously placed at my disposal the ample materials which it had cost them the labour of years to bring together, they asked no other return for the gift than that I should obtain the opinions of the best English palæontologists on their fossils. I have accordingly endeavoured by the aid of several friends, whose names appear frequently in this memoir, especially those of Messrs. S. V. Wood, Morris, Edwards, Rupert Jones, Hooker, and E. Forbes, to discharge the debt incurred to my foreign fellow-labourers; giving the results of their comparison of Belgian and British fossils, respecting which doubt and discussion had arisen, whether in reference to specific characters, or to position in the geological series.

It may also be well to state, before concluding, that, notwithstanding the slight inequalities of level and the rarity of natural sections in a

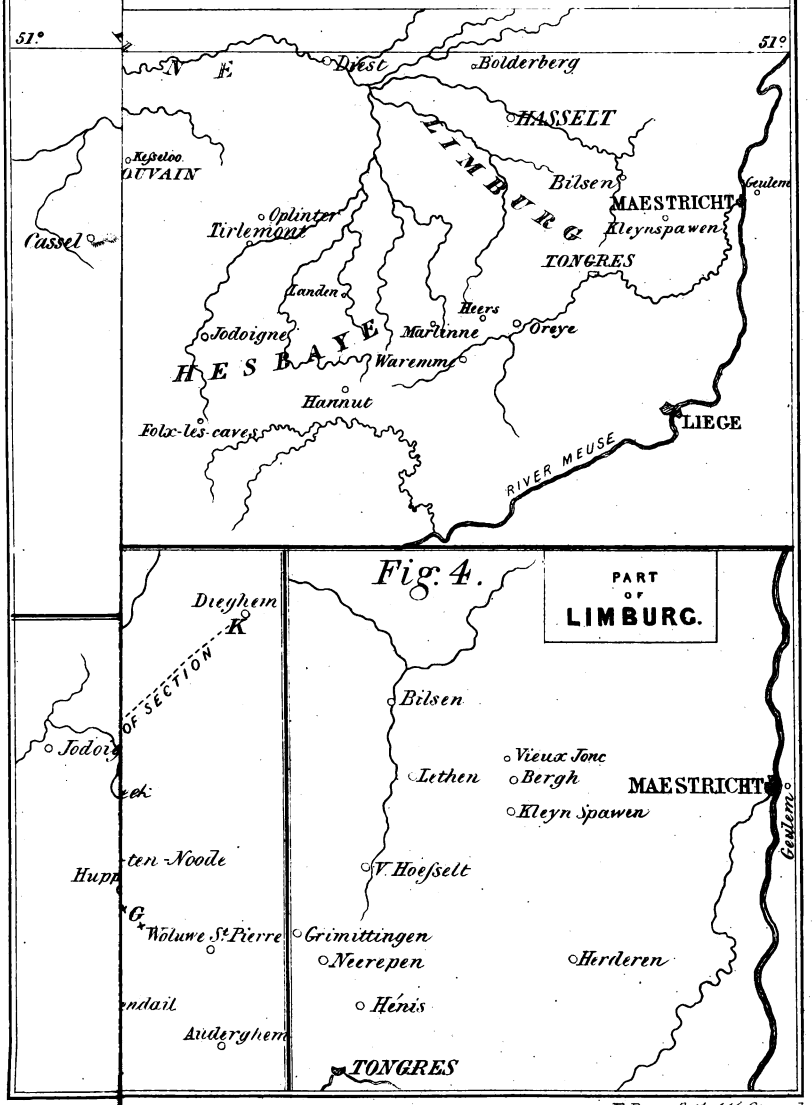
great part of Belgium, no European country of equal area affords a richer, perhaps no one so rich a field for the study of rocks newer than the White Chalk with flints. I have stated in the present memoir, that the older Pliocene or Crag strata of Suffolk are very fully represented at Antwerp, and that in the Limburg the Upper Eocene group is more completely developed than its equivalent in the Isle of Wight. The Bolderberg affords an example of beds intermediate between the two groups last mentioned (probably of the Miocene period), to which nothing similar in age has yet been found in England. Again, the chalk of Maestricht or Ciply, long recognized as an upper and peculiar member of the cretaceous system, is another rock of which we have no example in Great Britain. Last, not least, there have been discovered by M. Dumont and others, near Tournay and in different parts of Hesbaye, strata occupying a position between the Maestricht Chalk and the Lower London Tertiaries. These Lower Landenian and Heersian groups of Dumont promise no scanty harvest to the collectors of organic remains, and may, therefore, soon be made to throw light on a period of the earth's history as yet more obscure than any other of equally modern date. Judging from the character of the numerous publications which have appeared in Belgium during the last fifteen years, we may confidently affirm that the scientific explorers of that country will continue to prove themselves worthy of the grand field of investigation thus thrown open to them.

M A P

OF PARTS OF BELGIUM AND FRENCH FLANDERS

to accompany a memoir

by Sir Charles Lyell.



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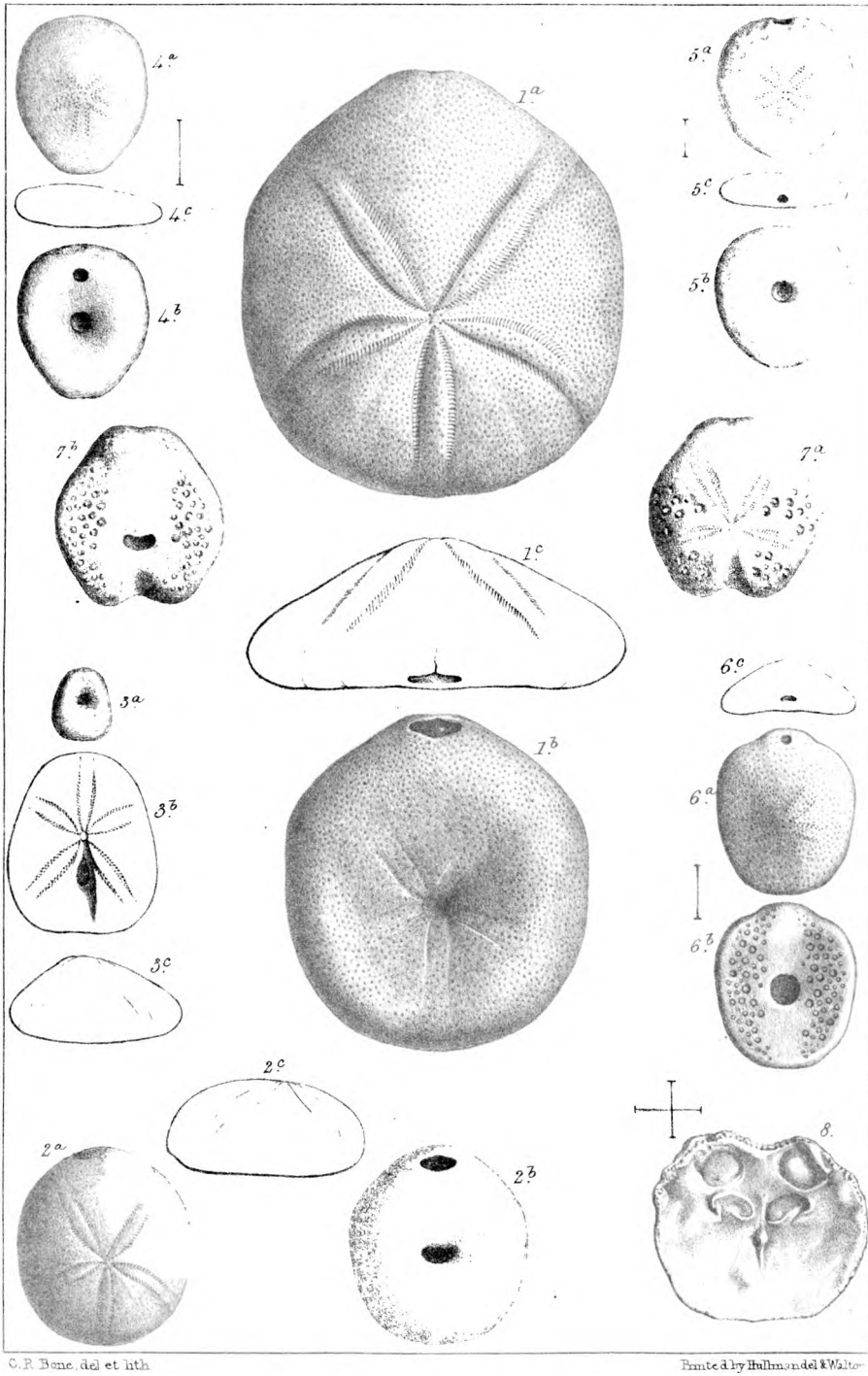

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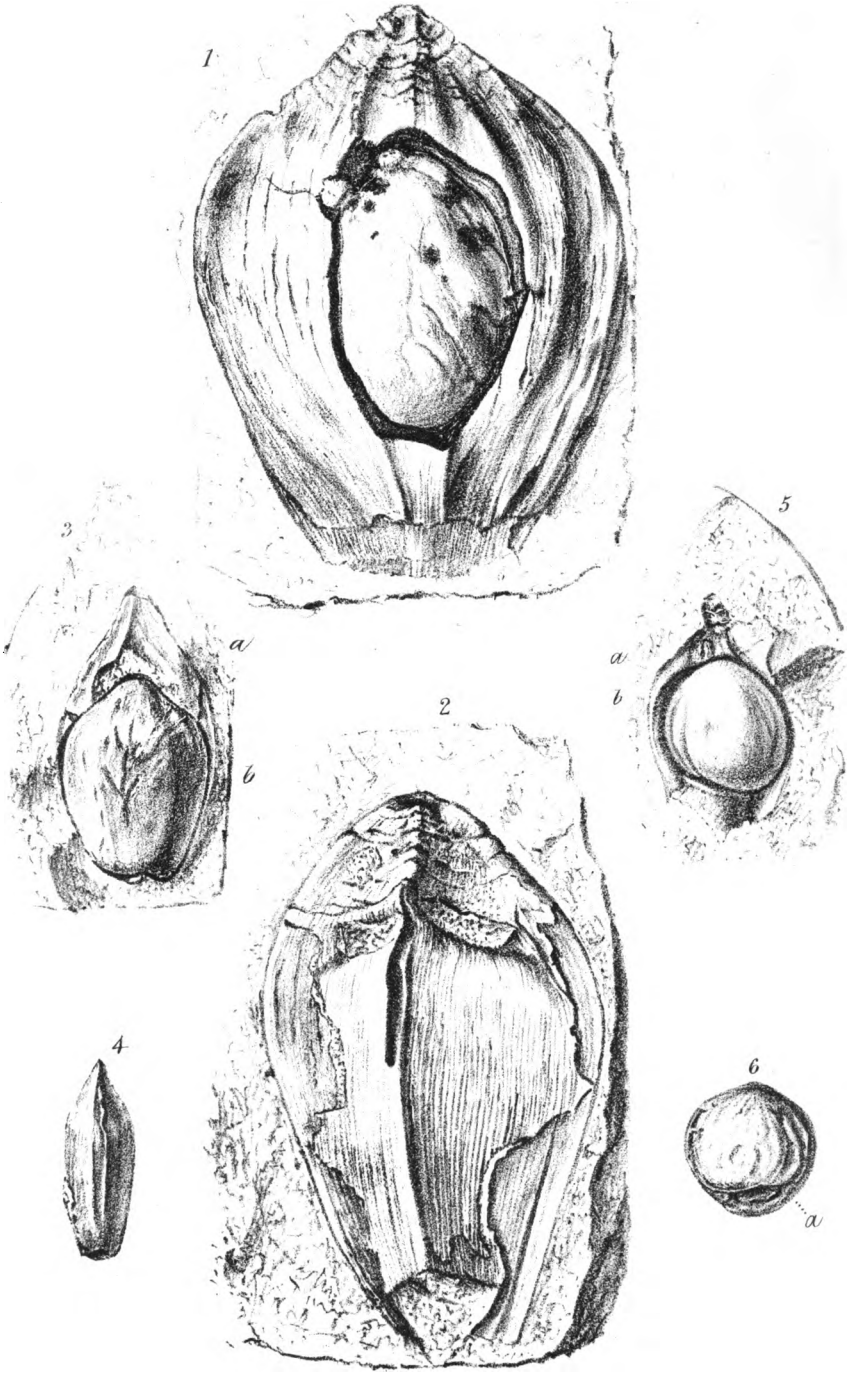
Eocene Fossils of Belgium.

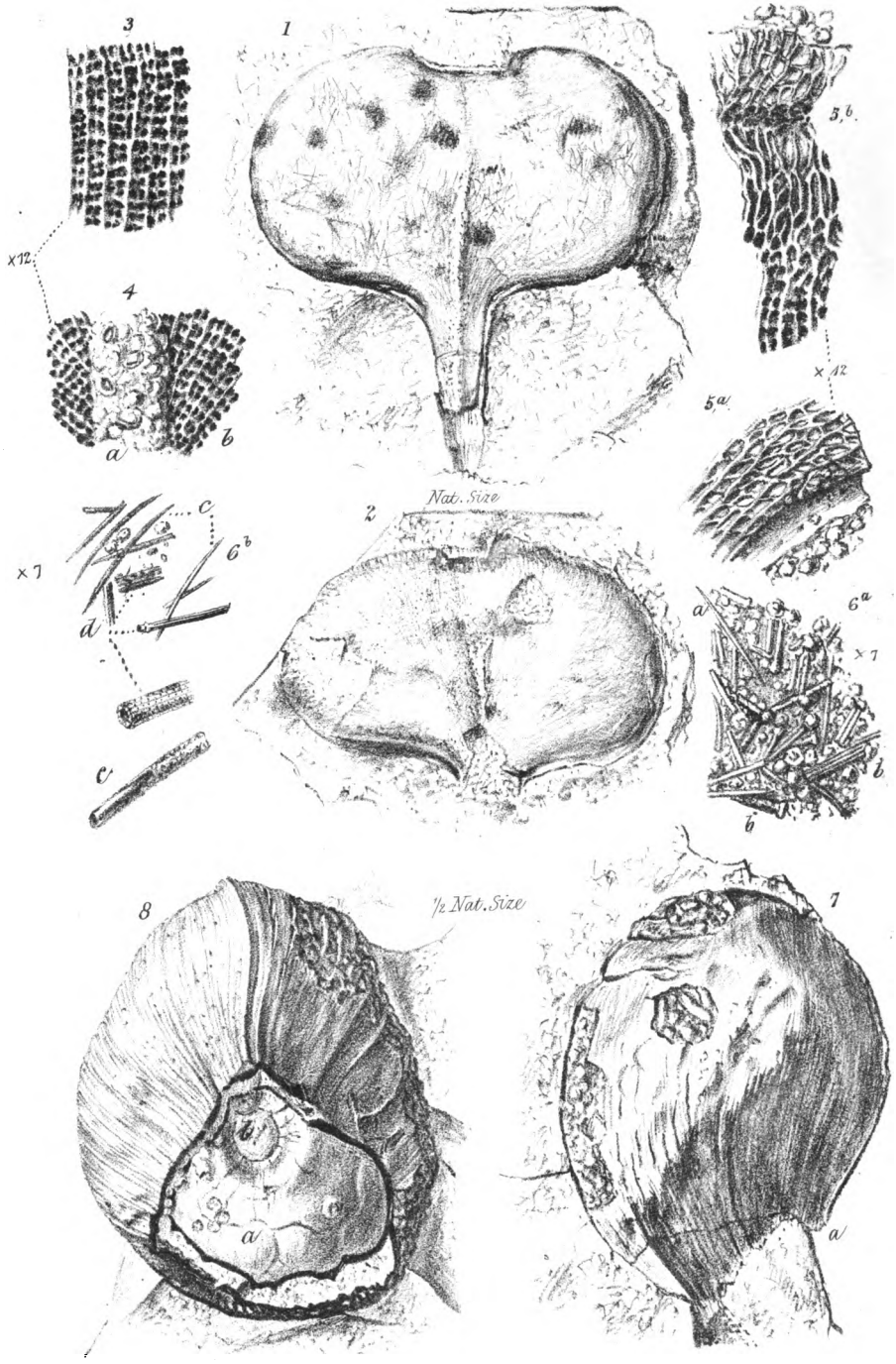


Eocene Fossils of Belgium

(Nipadites. ½, Nat. Size.)

Printed by C. Madely Wellington St.

J. de C. Sowerby Fecit.



Eocene Fossils of Belgium

(Nonium and Nipadites)

J.de C. Sowerby Fecit.

Printed by C. Madely Wellington St.

EXPLANATION OF PLATES XVII. XVIII. XIX. & XX

Plate XVII.

Fig. 1. Map of part of Belgium and French Flanders.
Figs. 2. 3. 4. Portions of the same, on enlarged scales.

Plate XVIII.

Fig. 1 *a*, 1 *b*, 1 *c*. Echinolampas Galeottianus, *E. Forbes*, nat. size.
Fig. 2 *a*, 2 *b*, 2 *c*. ——— Dekini, *Galeotti*, sp., nat. size.
Fig. 3 *a*, 3 *b*, 3 *c*. Nucleolites approximatus, *Galeotti*, nat. size.
Fig. 4 *a*, 4 *b*, 4 *c*. Echinocyamus propinquus, *Galeotti*, magnified
Fig. 5 *a*, 5 *b*, 5 *c*. Scutellina rotunda, *Galeotti*, sp., magnified.
Fig. 6 *a*, 6 *b*, 6 *c*. Lenita patelloides, *Galeotti*, sp., magnified.
Fig. 7 *a*, 7 *b*. Spatangus Omalii, *Galeotti*, nat. size.
Fig. 8. Crania Hoëninghausii, *Michelotti*, magnified.

Plate XIX.

Fig. 1. Nipadites Burtini, *Brongniart*, sp.
Fig. 2. ——— ———, ———, abortive fruit.
Fig. 3. ——— lanceolatus, *Bowerbank*: *a*, the pericarp; *b*, the nucleus or cast, representing the nut.
Fig. 4. ——— ———, nucleus, seen edgewise.
Fig. 5. ——— Parkinsonsis, *Brongniart*, sp.: *a*, pericarp; *b*, nucleus.
Fig. 6. ——— ———, nucleus: *a*, position of the opening at the base where the sand entered.

The figures are all ½ nat. size.

Plate XX.

Fig. 1. Honium Bruxelliense, *Lyell*, nat. size.
Fig. 2. ——— ———, ———, another specimen, nat. size.
Fig. 3. Portion of the surface of fig. 2, near the centre and to the left of the ridge, showing the reticulated structure. Magnified 12 diam.
Fig. 4. Portion of surface of fig. 2, a little below the centre, and including a part of the rough or granulated ridge: *a*, reticulations running obliquely downwards towards the ridge, *b*. Magnified 12 diam.
Fig. 5 *a*. Portion of surface of fig. 2, from the margin close to and on the right (as seen in the figure) of the peduncle, showing the reticulation on the rounded margin of the cast, and the smooth narrow cavity or sulcus formerly occupied by the blunt edge of the Honium. Magnified 12 diam.
Fig. 5 *b*. Portion of surface of fig. 2, from the sinus; the reticulation assumes the aspect of a wrinkled membrane. Magnified 12 diam.
Fig. 6 *a*, 6 *b*. Spines from the surface of fig. 1: *a*, *c*, *c*, sponge spicules; *b*, *b*, *d*, spines of Echinoderms. Magnified.
Fig. 7. Nipadites Burtini. *Brongniart*, sp., having the husk bored by Teredinæ: *a*, position of aperture at the base into which the sand has entered. ½ nat. size.
Fig. 8. ——— ———, ———, base of the same specimen: *a*, nucleus or cast of the endocarp; *b*, position of aperture. ½ nat. size.

Appendix No. I.

Table of the Classification of the Tertiary Series of Paris, Hampshire, London, and Belgium, in M. Dumont's communication, to the Royal Academy of Belgium, "Sur le Synchronisme des formations tertiaires de la Belgique, de l'Angleterre et du nord de la France," August 2, 1851.*

	BELGIQUE.			BASSIN DE PARIS.	BASSIN DU HAMPSHIRE.	BASSIN DE LONDRES.
2me série (pliocène)	Système scaldisien ..			Crag du Cotentin? ..	.....	Crag.
	Système diestien					
1re série. Miocène.....	Système bolderien ..	Nymphéen (lignite du Rhin).				
		Marin.....		Falun de Touraine?		
Eocène supérieur ou miocène inf.	Système rupelien	Argile schistoïde de Boom.....		Dépôt lacustre supérieur.		
		Sable jaunâtre		Sable de Fontainebleau.		
Eocène supérieur....	Système tongrien....	Argile verte de Henis		Couche à *Cyrena semistriata*, etc.		
		Sable glauconifère de Lethen		Dépôt lacustre moyen.	Dépôt lacustre de l'île de Wight.	
	Système laekenien ..	Sable sans fossiles		Sable moyen.....	Sable sans fossiles d'Hordwell.	
		Sable fossilifère de Laeken		Couche à *Nummulina variolaria* de Cassel.	Argile de Barton †.	
Eocène moyen	Système bruxellien ..	Sable quarzeux.....		Calcaire grossier	Sable de Bracklesham.	Sable de Bagshot.
		Sable calcareux				
		Sable glauconifère				
	Système paniselien ..	Argilo-sableux.				
	Système ypresien	Sable		Partie des sables inférieurs.	Argile de Bognor....	Argile de Londres.
		Argile.....				
Eocène inférieur	Système landenien ..	Nymphéen.....		Lignite soissonnais ..	Plastic clay	Plastic clay.
		Marin.....		Glauconie inférieure.		
	Système heersien	(Crétacé).				

* Bulletin Acad. Roy. de la Belgique, tom. xviii. no. 8.

† En admettant, avec M. Prestwich, que le sable de Bracklesham correspond au calcaire grossier, et, par conséquent, au système bruxellien, l'argile de Barton correspondra à la partie fossilifère inférieure de mon système laekenien, dont il paraît, d'ailleurs, renfermer plusieurs espèces fossiles (*Corbula pisum, Venus Solandri, Cypricardia pectinifera, Pecten corneus, Turritella brevis, Bulla constricta, Bulla Sowerbyi*).

To face page 370.

Tableau Chronolo[g]hire et de Londres, suivant la Classification [S]ociété Géol. de Londres.

[Communi[c]s of the stratigraphical relations of the Ter[t]ngland in the summer of 1851.]

BELGI	BASSIN DE LONDRES.	
Système tongrien..	Et Et	
Système laekenien..	à grains moyens jaunatre et grès blanc. Et demi-fin. Et glauconifère.	Bagshot sand supérieur.
Système bruxellien	Et à grains moyens. e et sable glauconifère (1-5). argileux glauconifère. Et très glauconifère ($\frac{3}{4}$-$\frac{1}{2}$), plus ou moins ileux, avec couches de sable argileux fin.	Bagshot sand moyen.
Système paniselien?..	te. e sableuse à grains très fin avec un lit de le glauconifère de Woking.	Bagshot sand inférieur.
Système ypresien..	Et à gros grains et à grains moyens. fin glauconifère avec lits d'argile sableuse rains fins. e plastique et argile sableuse. Et glauconifère à dents de Lamna.	London clay.
Système landenien	e sableuse, sable argileux glauconifère (1-30). e plastique bigarrée et trace de lignite. à grains moyens. lit de cailloux et calcaire caillouteux fossi- re. Ethe fossilifère et lit d'argile quarzifère schis- le. nite cloisonnée. glauconifère et lits d'argile schistoïde. de cailloux. à grains moyens silexifère (1-25). argileux silexifère (1-10). Et mite glauconifère (1-10). mite silexifère ($\frac{1}{2}$). reniformis.	Plastic clay.